BIOSTRATIGRAPHIC AND PALEOECOLOGIC IMPLICATIONS OF THE FIRST EOCENE LAND MAMMAL FAUNA FROM THE NORTH AMERICAN COASTAL PLAIN

APPROVED BY
SUPERVISORY COMMITTEE:

Ernest Lundelius Jr.

John A. Wilson

Martin B. Eggar

Stephen A. Hall

Frank C. Whitmore

Copywrite

by

James William Westgate

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by

JAMES WILLIAM WESTGATE, B.S., M.S., M.S.

DISSERTATION

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Supervising Professors: John A. Wilson and Ernest L. Lundelius, Jr.

A newly discovered vertebrate fossil assemblage, the Casa Blanca local fauna, comes from the Laredo Formation, Claiborne Group, of Webb County, Texas, and is the first reported Eocene land mammal fauna from the coastal plain of North America. The mammalian fauna is correlated with the Serendipity and Candelaria local faunas of west Texas, the Uinta C faunas of the Rocky Mountains, the Santiago Formation local fauna of southern California, and the Swift Current Creek local fauna of Saskatchewan. The vertebrate-bearing deposit lies approximately 32 m above a horizon containing the marine gastropod Turritella cortezi which ranges from east Texas to northeast Mexico in the lower half of the Cook Mountain and Laredo Formations and is a guide fossil to the Hurricane Lentil in the Cook Mountain Formation. Nannoplankton found in these middle Eocene formations belong to the upper half of

Nannoplankton Zone 16 and allow correlation with European beds of upper Lutetian to lower Bartonian age.

The Casa Blanca fauna includes eight chondrichthyan, six osteichthyan, one amphibian, 10 reptilian and one avian species. More than 600 specimens represent at least 30 species of 28 mammal genera. The Casa Blanca fauna is the southernmost and easternmost North American land mammal fauna of definite Eocene age, and is the westernmost Paleogene vertebrate fauna from the Gulf Coastal Plain. Four lower vertebrate species previously known from the Old World are reported from Eocene deposits of North America for the first time. Local paleoecologic conditions probably resembled those of the present day coastal areas of southern Mexico and northern Central America.

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INTRODUCTION

In March 1984, Karen C. Westgate and the author discovered weathered remains of Eocene land mammals in an exposure of the Laredo Formation just east of the city of Laredo, Texas, near the south shore of Lake Casa Blanca (Figs. 1, 2). The Laredo Formation is a marine to marginal marine member of the middle Eocene Claiborne Group deposited in the Rio Grande Embayment. Subsequent excavations have yielded nearly 700 mammalian specimens representing a minimum of 30 taxa. At least 26 species of lower vertebrates are associated with the mammalian remains. These fossils constitute the Casa Blanca local fauna (Table 1).

Reports of Eocene land mammals from North American Coastal Plain deposits are rare. Most specimens known are fragmentary and not associated with other mammalian taxa. This has resulted in tenuous stratigraphic correlations between the Eocene deposits of the continental interior and the Coastal Plain. The aim of this study is three fold. The primary objective is to report the first highly diverse land mammal fauna and associated lower vertebrate remains described from an Eocene marine unit of the North American Coastal Plain. The second is to compare this fauna with faunas known from the continental interior to better refine stratigraphic correlations between each province and more precisely synchronize the Eocene North American Land Mammal Ages with time scales based on marine faunas. The third objective is to interpret the paleoecologic evidence

TABLE 1. List of vertebrate taxa in the Casa Blanca local fauna.

		# of Specimens*
CHONDRICHTHYES:		
	Striatolamia macrota	59
	Carcharhinus sp.	78
	Galeocerdo eaglesomei	344
	Pristis sp.	16
	Rhinobatos sp.	1
	Dasyatis sp.	3
	Myliobatis sp.	1
	Rhinoptera sp.	10
OSTEICHTHYES:		
	Lepisosteus sp.	391
	megalopid	6
	cf. Paralbula marylandica	100+
	cf. Arius sp.	80
	Diaphyodus n. sp.	29
	Jefitchia sp.	1
AMPHIBIA:		
	anuran	3
REPTILIA:		
	cf. Baptemys sp.	*
	cf. Allaeochelys sp.	*
	Trionyx sp.	*
	Xenochelys sp.	*
	emydid	*
	Hadrianus sp.	*
	Allognathosuchus sp.	51
	Pristichampsus cf. P. vorax	28
	cf. Glyptosaurus sp.	10
	Pterosphenus schucherti	11
AVES:		
	bird	1
MAMMALIA:		
Marsupalia		
	Peratherium comstocki	3
	P. marsupium	4

MAMMALIA: (cont.)		
Insectivora		
	cf. Simidectes magnus	1
	Centetodon pulcher	5
Primates		
	Omomys n. sp.	10
	Macrotarsius cf. M. jepseni	1
	Microsyops sp.	11
Condylarthra		
	mesonychid	2
	Hyopsodus cf. H. uintensis	3
Carnivora		
	cf. Uintacyon sp.	1
	Procynodictis cf. P. vulpiceps	1
Sirenia		
	sirenian	1
Perissodactyla		
	Epihippus cf. E. gracilis	12
	Amynodon advenus	5
	brontotherid	6
Artiodactyla		
	leptochoerid	6
	Protoreodon petersoni	8
	Leptoreodon pusillus	3
	L. leptolophus	24
	Toromeryx marginensis	9
Rodentia		
	Mytonomys robustus	68
	Thisbemys sp.	*
	Microparamys sp.	*
	ischyromyid, 2 gen. and spp. undet.	*
	Pauromys n. sp.	*
	cylindrodontid, n. gen. and sp.	*
	?eutypomyid, n. gen. and sp.	*
	Family undet., n. gen. and sp.	*
Undetermined		
	large mammal	1

*Specimen counts not given for turtles and rodents understudy.

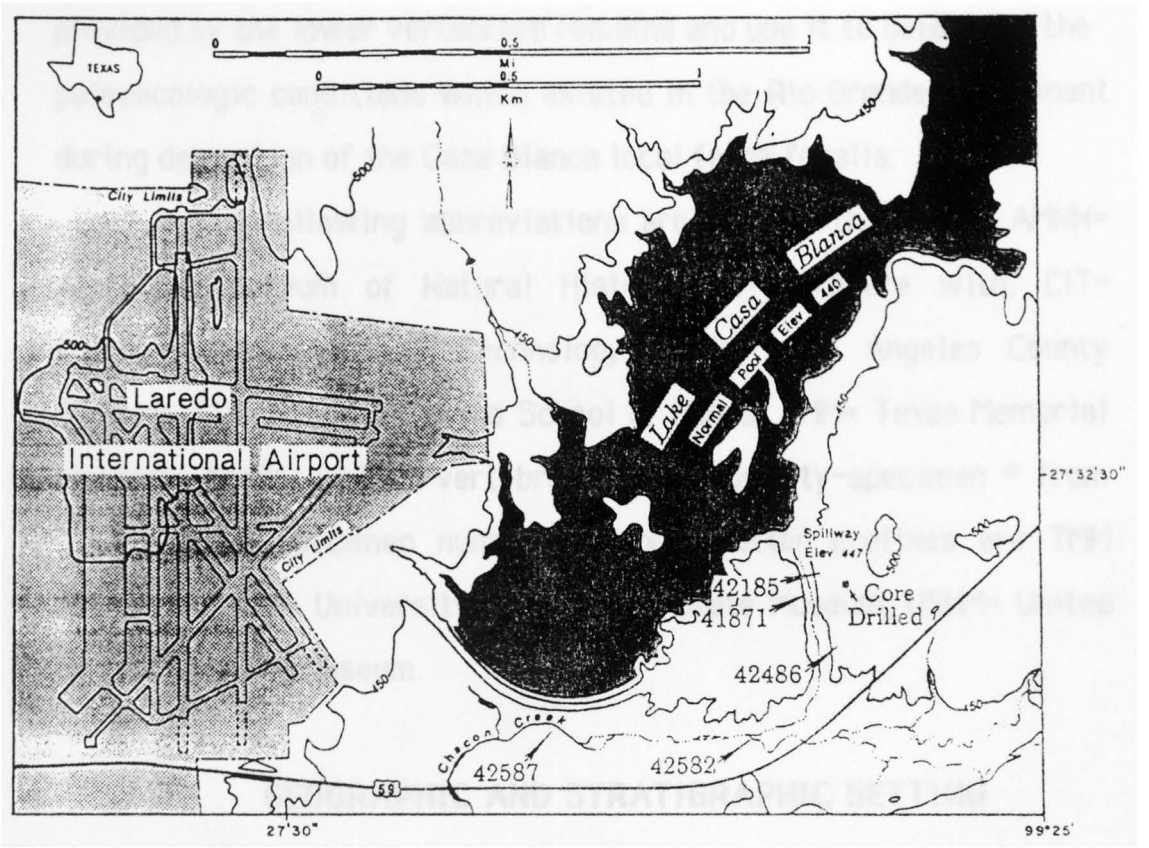


FIGURE 1. Location of the Texas Memorial Museum Casa Blanca local fauna fossil localities and the core drill-site near Lake Casa Blanca, due east of Laredo, Webb County, Texas.

provided by the lower vertebrate remains and use it to determine the paleoecologic conditions which existed in the Rio Grande Embayment during deposition of the Casa Blanca local fauna fossils.

The following abbreviations are used in this paper: AMNH= American Museum of Natural History, cf.= compare with, CIT= California Institute of Technology, LACM= Los Angeles County Museum, SDSM= South Dakota School of Mines, TMM= Texas Memorial Museum; 42486-1= TMM vertebrate fossil locality-specimen # from the locality, specimen numbers without letter prefixes are TMM numbers, UNSM= University of Nebraska State Museum, USNM= United States National Museum.

GEOGRAPHIC AND STRATIGRAPHIC SETTING

The Casa Blanca local fauna was collected from an exposure in the high water spillway on the southeast side of Lake Casa Blanca in Webb County, Texas (Fig. 2). The spillway is 2.5 km due east of the Laredo International Airport and the Laredo city limits. The fossil quarry, Texas Memorial Museum vertebrate fossil locality 42486 is located at latitude 27 32'N, longitude 99 26'W, at an approximate elevation of 140 m (460 ft) as indicated on the USGS Laredo East, Tex. 7.5' (1965) topographic quadrangle.

Beds exposed at the quarry belong to the Laredo Formation which locally strikes north-south; dips east at approximately 4 ; is

FIGURE 2. The Casa Blanca local fauna quarry site, TMM 42486. **A**. Location of the quarry on the east side of the spillway of Lake Casa Blanca, view looking northeast from the southwestern corner of the spillway. **B**. Location of the quarry horizon 4 m above the spillway floor.

A

B

composed of marginal marine sands, clays and marls; and has a local thickness of 192 m in Webb County (Lonsdale and Day, 1937:43-44). Regionally, the Laredo Formation is underlain by the El Pico Clay and overlain by the Yegua Formation. These three formations comprise the uppermost units of the Claiborne Group in the Rio Grande Embayment and are considered middle Eocene in age (Eargle, 1968). The Laredo Formation was formerly considered to be a southern extension of the Cook Mountain Formation of central and east Texas, Louisiana, Mississippi and Arkansas. Gardner (1938) separated the distinctively sandier deposits exposed southwest from Frio, McMullen and Live Oak Counties and into Mexico, from their northern more clayey equivalents, naming the southern deposits the Laredo Formation. Unfortunately, many workers failed to make this distinction after 1938 and some confusion of terminology exists in the literature. Eargle (1968) presented the current status of stratigraphic terminology for Claiborne Group deposits of the Rio Grande Embayment.

The Laredo Sheet of the Geologic Atlas of Texas (1976) indicates that the Lake Casa Blanca dam lies over the middle portion of the Laredo Formation. Exposures just below the dam have yielded specimens of Turritella cortezi (42587-1) from a Crassostrea amichel (Gardner) (42487-2) bioherm (Figs. 3, 4, 5 and 6). Stenzel (1940) has shown that T. cortezi has a short stratigraphic range and used it as a guide fossil to correlate a thin zone of strata from Webb

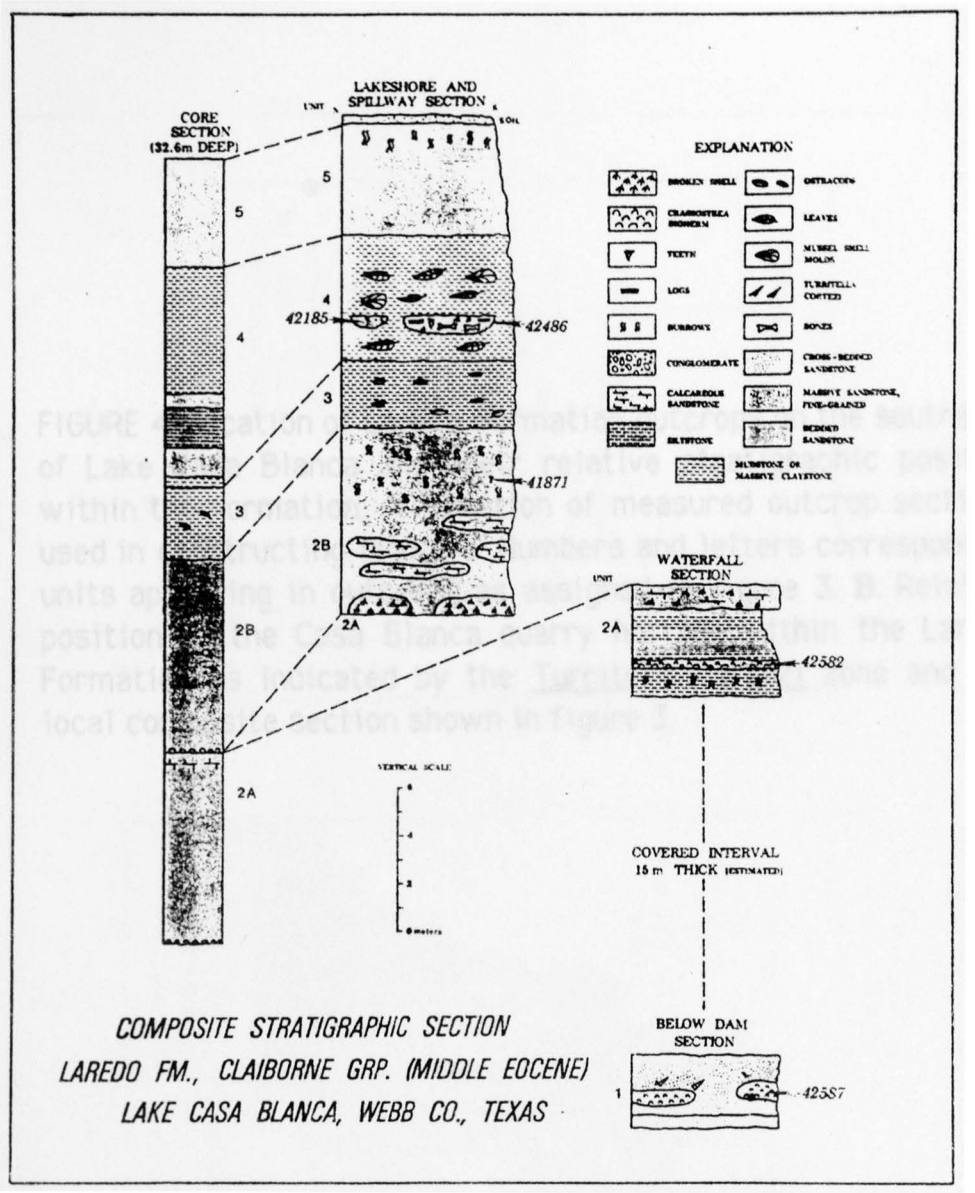
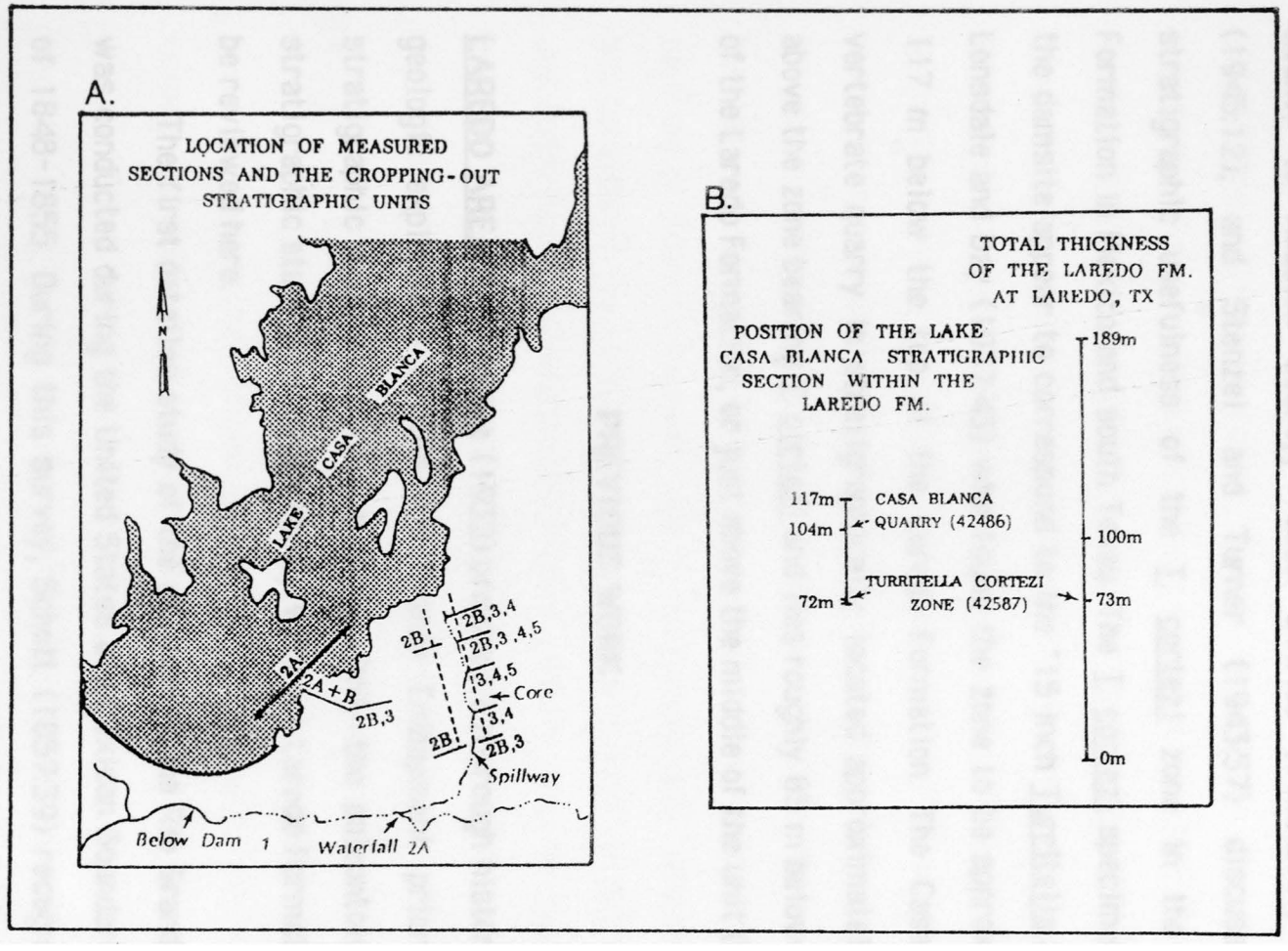


FIGURE 3. Composite stratigraphic section of Laredo Formation beds exposed on the south side of Lake Casa Blanca. Information derived from outcrop and drill core data. Five digit numbers show relative positions of TMM fossil localities.

FIGURE 4. Location of Laredo Formation outcrops on the southside of Lake Casa Blanca and their relative stratigraphic position within the formation. **A**. Location of measured outcrop sections used in constructing figure 3. Numbers and letters correspond to units appearing in outcrops as assigned in figure 3. **B**. Relative position of the Casa Blanca quarry horizon within the Laredo Formation as indicated by the Turritella cortezi zone and the local composite section shown in figure 3.


A.
LOCATION OF MEASURED SECTIONS AND THE CROPPING-OUT STRATIGRAPHIC UNITS
N
LAKE
CASA
BLANCA
2A
2A+B
2B,3
2B
2B,3,4
2B,3,4,5
3,4,5
Core
3,4
2B,3
Spillway
Below Dam 1
Waterfall 2A
B.
TOTAL THICKNESS OF THE LAREDO FM. AT LAREDO, TX
POSITION OF THE LAKE CASA BLANCA STRATIGRAPHIC SECTION WITHIN THE LAREDO FM.
189m
117m
CASA BLANCA
104m
QUARRY (42486)
100m
TURRITELLA CORTEZI
72m
ZONE (42587)
73m
0m

County to Houston County, Texas. Bowles (1939:273), Gardner (1945:12), and Stenzel and Turner (1943:57) discussed the stratigraphic usefulness of the I. cortezi zone in the Laredo Formation in Mexico and south Texas. The I. cortezi specimens from the damsite appear to correspond to the "15 inch Turritella zone" of Lonsdale and Day (1937:43) who found the zone to be approximately 117 m below the top of the Laredo Formation. The Casa Blanca vertebrate quarry is stratigraphically located approximately 32 m above the zone bearing I. cortezi and lies roughly 85 m below the top of the Laredo Formation, or just above the middle of the unit (Fig. 4B).

PREVIOUS WORK

LAREDO AREA. Trowbridge (1932) provided a thorough history of the geologic exploration of the Rio Grande Embayment prior to his stratigraphic description of the region. Only the paleontologic and stratigraphic studies dealing directly with the Laredo Formation will be reviewed here.

The first detailed study of the geology of the Rio Grande Valley was conducted during the United States and Mexican Boundary Survey of 1848-1855. During this survey, Schott (1857:39) recognized the presence of Tertiary "green sands" in the lower Rio Grande Valley but incorrecty reported that the Tertiary outcrops along the Rio Bravo (Rio Grande) alternated with outcrops of Cretaceous strata. Conrad

(1857:143) presented a list of fossils supposedly collected three miles below Laredo by Schott, but at some point the specimens apparently were mislabeled. The list includes such typical Cretaceous species as Inoceramus crispii, I. texanus and Exogyra costata. This error went uncorrected for almost 30 years as evidenced by the stratigraphic confusion that existed in the mid-1880's regarding the age of the deposits exposed at Laredo. Cope (1884:753) proposed that the beds exposed on the Rio Grande River at Laredo were probably of the Laramie Formation and that Claiborne beds there locally overlie the Laramie. Hill (1887:85-86) recognized some confusion in the labeling of Schott's boundary survey specimens and Conrad's report, but considered the strata underlying Laredo to be of Cretaceous age and suggested the Cretaceous-Tertiary contact must be many miles east of the city. Heilprin (1884:334) was the first worker to correctly recognize the similarity between the fossils found in the Laredo area and those from Claiborne (Eocene) beds to the east.

Penrose (1890:44-45) reported the first vertebrate fossils found in what is now known as the Laredo Formation in noting the presence of shark teeth in outcrops both 8 km (5 mi) below Laredo and 35 km (21 mi) south of Laredo near San Ignacio, Texas in Zapata County. Udden, Baker and Bose (1916:92) correlated some of the Claiborne deposits exposed along the Rio Grande with the Cook Mountain Formation of east Texas and extended the use of the term Cook Mountain Formation to Webb County. Vaughan (1919) and Trow-

bridge (1923) noted that previous stratigraphers had not recognized the change in strike of the Cook Mountain Formation at Laredo from southwest to southeast. Outcrops of the formation stretch southerly along the Rio Grande River for 125 km (75 mi) below Laredo.

Wrather (1921:625) reported the first commercially important discovery of oil not associated with known salt domes in southwest Texas (natural gas had been recovered in the region for some time). The oil well was drilled into the top of the Cook Mountain Formation in northeastern Zapata County.

Gardner (1923) described new species of molluscs from Eocene deposits of the Rio Grande Embayment incuding several forms from the Cook Mountain Formation. Deussen (1924) presented a detailed map showing the Cook Mountain Formation extending from the Brazos River southwest to northcentral Webb County (the area of Webb County adjacent to the Rio Grande was not mapped). Trowbridge (1932) presented an excellent summary of the stratigraphy of the lower Rio Grande Valley.

Kane and Gierhart (1935) correlated Eocene outcrops in northeastern Mexico with exposures found on the U. S. side of the Rio Grande. Lonsdale and Day (1937) evaluated the ground-water potential of the Cenozoic strata underlying Webb County and provided detailed outcrop descriptions in addition to those of Trowbridge (1932). Gardner (1938) coined the term Laredo Formation for strata formerly

called "Cook Mountain" in the Rio Grande Embayment, as noted earlier. Bowles (1939) descibed Paleogene turritelids from the North American Coastal Plain including species from the "Cook Mountain" [Laredo Formation] of Texas and Mexico. Stenzel (1940) described the Hurricane Lentil, a zone characterized by the presence of Crassatella texalta and Turritella cortezi in exposures of the Cook Mountain Formation of Leon and Houston Counties (east Texas) and correlated the zone over 600 km (365 mi) southwest to beds of the "Cook Mountain" [Laredo Formation] bearing the same species in Webb County and Tamaulipas, Mexico. Patterson (1942) divided the "Cook Mountain" [Laredo Formation] into three members; the Garceno Sandstone, Veleno Member and Falcon Sandstone, from oldest to youngest. Gardner (1945) described molluscan faunas from the Tertiary deposits of northeastern Mexico and compared them to faunas found north of the Rio Grande.

Eargle (1968) summarized the views of the U. S. Geological Survey on the status of Tertiary stratigraphic terminology for the Rio Grande Embayment and correlated the Laredo Formation with both the Cook Mountain and Sparta Sand formations to the east. Recently, Dodge and Posey (1981) presented cross sections of the Tertiary formations of the Texas Gulf Coast which allow a generalized three-dimensional view of the Laredo Formation which they included in their "lower Claiborne" (pre-Yegua Formation) depositional package.

Vertebrate remains have recently been reported from the Laredo

Formation. Domning, Morgan and Ray (1982:8) noted the collection around 1950 of a partially articulated vertebral column and rib cage of an unidentifiable sirenian (41843-1) from the "Cook Mountain Formation" [Laredo Formation] in southern Zapata County, Texas. Two vertebrate specimens were collected from the Lake Casa Blanca spillway prior to the discovery of concentrated remains in 1984. A mandible of Leptoreodon leptolophus (41871-1) was collected in 1976 (Wilson, 1984) and an ulna from the rhino Amynodon advenus (42185-1) was discovered in 1979 and reported in 1986 (Wilson, 1986:363). Westgate (1987) presented a preliminary list of mammals in the Casa Blanca fauna.

COASTAL PLAIN EOCENE LAND MAMMALS. The large number of mammalian remains in the Casa Blanca fauna is unique for Eocene deposits of the North American Coastal Plain. Only 10 land mammals have previously been reported from the Eocene exposures elsewhere in this region. The following records indicate what little is known of the Eocene faunas which inhabited the coastal plain.

The sole Atlantic Coastal Plain Eocene land mammal occurrence is a tillodont left M_2(?) that Leidy (1868) described and named Anchippodus riparius. The specimen was collected from the Shark River Formation of Monmouth County, New Jersey which Ward (1985:3) recently considered to be of early Eocene age. Gazin (1953) figured this specimen in his review of the Tillodontia, but questioned

whether this tooth was taxonomically diagnostic at the generic level. No land mammals have been reported from lower Eocene deposits of the Gulf Coastal Plain.

Westgate (1986) reviewed the occurrences of land mammals reported from Eocene deposits of the Gulf Coastal Plain. The following account summarizes that review. Four land mammal specimens were reported from formations of the Claiborne Group prior to 1986. Thurmond and Jones (1981:175) reported the discovery of a partial M_1 of Vulpavus sp. in the Gosport Sand of Clarke County, Alabama. Gazin and Sullivan (1942) described the titanothere Notiotitanops mississippiensis from a skull and mandible collected in Clarke County, Mississippi. The mammal yielding horizon is now referred to the Archusa Marl Member of the Cook Mountain Formation (Dockery, 1980:45). Dockery (1980:45) noted finding a rhinoceros rib in the Dobys Bluff Tongue of the Kosciusko Formation in Clarke County, Mississppi. As previously mentioned, Wilson (1984:205) figured a mandible of Leptoreodon leptolophus from the Laredo Formation of Webb County, Texas. After Westgate's (1986) review, Wilson (1986:363) noted the discovery of an ulna of Amynodon advenus near the Leptoreodon leptolophus site. More recently, Westgate (1987) published a preliminary list of the Casa Blanca mammals. I have recently found a reference (Berry, 1924:9) to the discovery of a small mammal femur at a coal mine at Dolores, Texas. The bone presumably came from the El Pico Clay, Claiborne Group, but

Berry (1924) did not indicate the fate of the specimen.

Only five land mammal specimens are reported from late Eocene deposits of the Coastal Plain. All five come from the Jackson Group. Domning, Morgan and Ray (1982:3) reported two probable entelodont teeth from the Tivola Limestone and Twiggs Clay of Twiggs County, Georgia. The Tivola Limestone occurrence had earlier been reported by Voorhies (1969) as a sirenian tooth. Westgate and Emry (1985) figured two land mammal specimens from undifferentiated Jackson Group deposits in St. Francis County, Arkansas. An M^3 and maxillary fragment was assigned to an agriochoerid, cf. Diplobunops matthewi, and an edentulous mandible was assigned to cf. Pantolestes natans. The agriochoerid specimen had originally been assigned to Protoreodon cf. P. pumilus (Westgate, 1981). Slaughter (1978) described the only late Eocene land mammal from the Texas Coastal Plain. The specimen is a didelphine marsupial dP^3 or M^1 from the Wellborn Formation of Polk County.

DEPOSITIONAL ENVIRONMENT

Laredo Formation exposures are found in the high-water spillway and its drainage valley near Lake Casa Blanca, along the lake shore, and below the dam (Fig. 4A). Approximately 15 m of the section is covered by Lake Casa Blanca. A 32.6 m core was drilled by the University of Texas Bureau of Economic Geology on the east side of

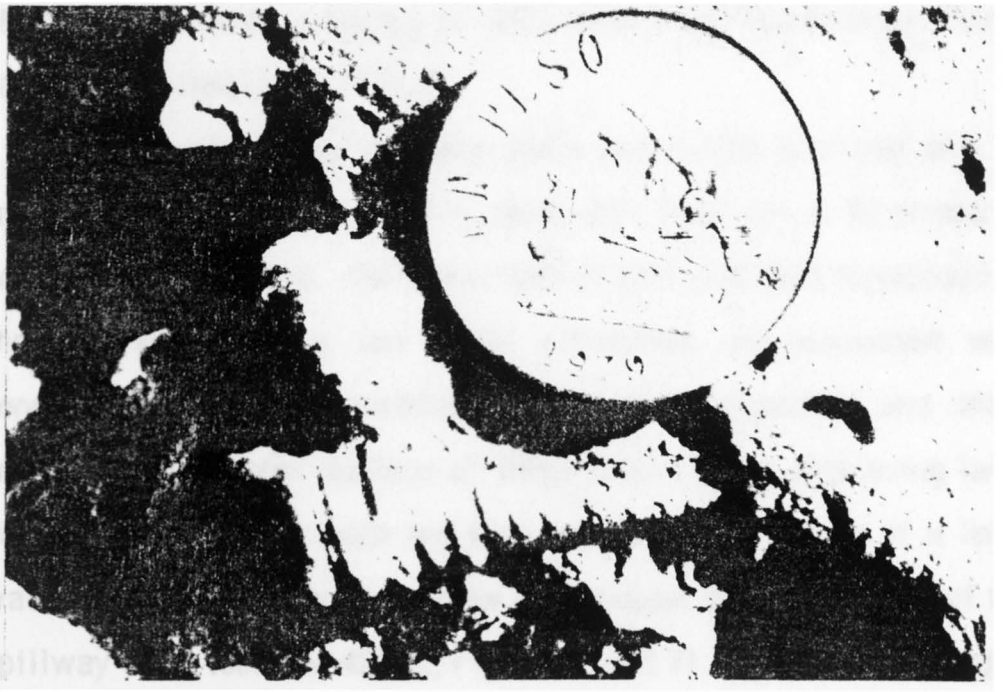
FIGURE 5. Outcrops of Unit 1, Laredo Formation, exposed below the Lake Casa Blanca dam. **A**. A Crassostrea amichel bioherm in the foreground surrounded by cross-bedded fine sand. **B**. Close-up view of cross-bedded sand shown in the background of figure 5A. Note rock hammer near center of photo for scale.

A

B

FIGURE 6. Close-up views of fossils in Unit 1, Laredo Formation, exposed below the Lake Casa Blanca dam. **A**. A Crassostrea amichel bioherm with a rock hammer for scale. **B**. An in situ shell of Turritella cortezi associated with a bioherm of C. amichel. The coin is 29 mm in diameter.

A



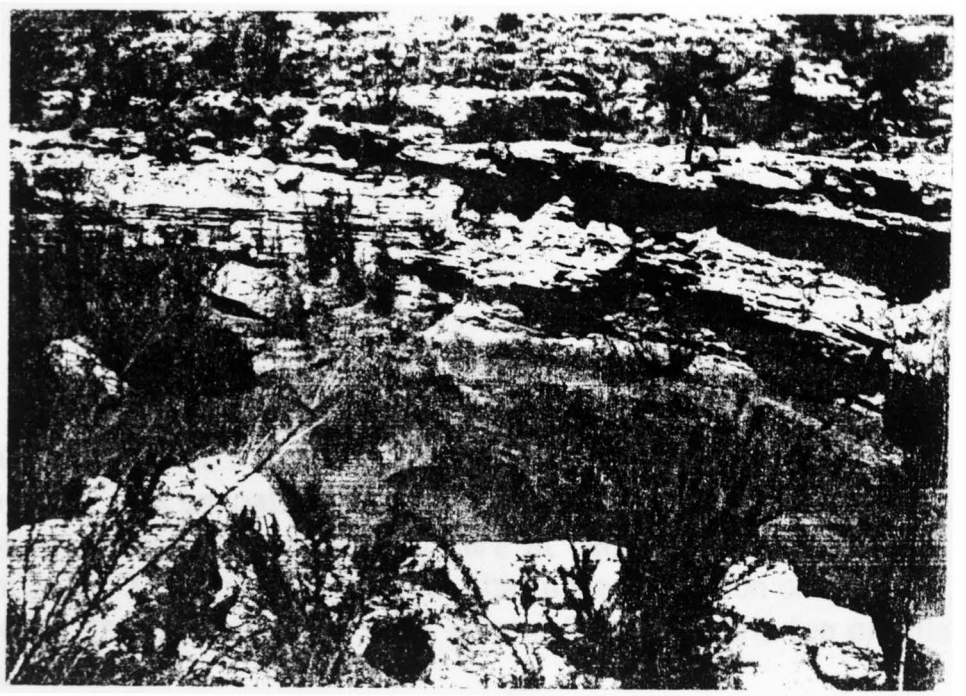
B

the spillway at the highest part of the stratigraphic section to obtain unweathered samples for paleomagnetic and microfossil analyses. Combined data from both outcrops and core samples have allowed construction of a composite stratigraphic section over 40 m thick (Fig. 3). This stratigraphic section lies in the middle portion of the Laredo Formation (Fig. 4B)

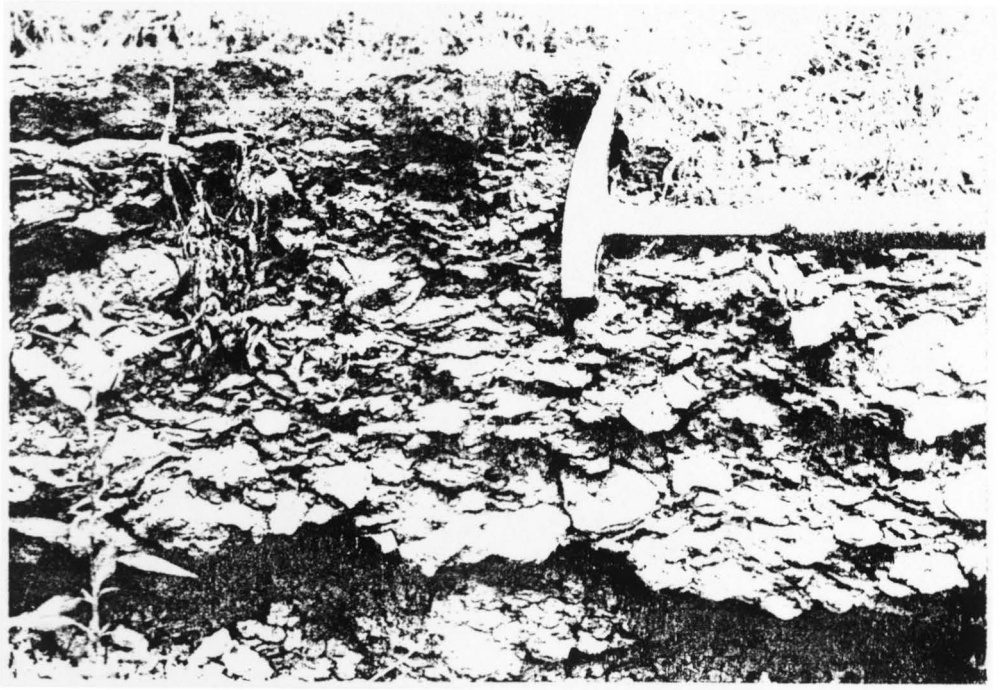
The lowest beds in the section are exposed below the dam (TMM locality 42587, Figs. 1, 5 and 6) and include a Crassostrea amichel (Gardner, 1945:81) bioherm (Fig. 6A, 42587-1) underlain by and laterally changing to cross-bedded fine sands (Fig. 5B). The previously discussed remains of Turritella cortezi (Fig. 6B, 42587-2), and steinkerns resembling Natica sp. also come from this bioherm. These beds are labelled Unit 1 (Fig. 3).

Outcrops along the lake shore and in the spillway and its drainage valley display a 14 m thick unit (Unit 2A & B) primarily composed of fine sand. The lower half of this unit (2A) is exposed on the lake shore during low water conditions and possesses well consolidated lenses containing oyster shell fragments and shark teeth, with the upper surface of these lenses often displaying large ripple marks. Similar beds are also exposed in the walls of a large waterfall and plunge pool complex in the upper drainage valley of the spillway (TMM locality 42582, Figs. 1, 4 and 7). Crassostrea amichel bioherms (Fig. 7B, 42482-1), serpulid worm tubes (42582-2) and steinkerns of ?naticid gastropods are exposed next to the plunge pool.

FIGURE 7. Outcrops of Unit 2A, Laredo Formation, exposed in the upper drainage valley of the Lake Casa Blanca spillway. **A**. Outcrops at the waterfall and plunge pool. Note figure standing on the cap rock in the upper right part of the photo. **B**. Close-up of a Crassostrea amichel bioherm exposed above pool level. Most individuals are articulated juveniles which appear to have been buried by the 5 cm thick bed of sand shown adjacent to the hammer tip. Many of these oysters are encrusted with serpulid worm tubes.



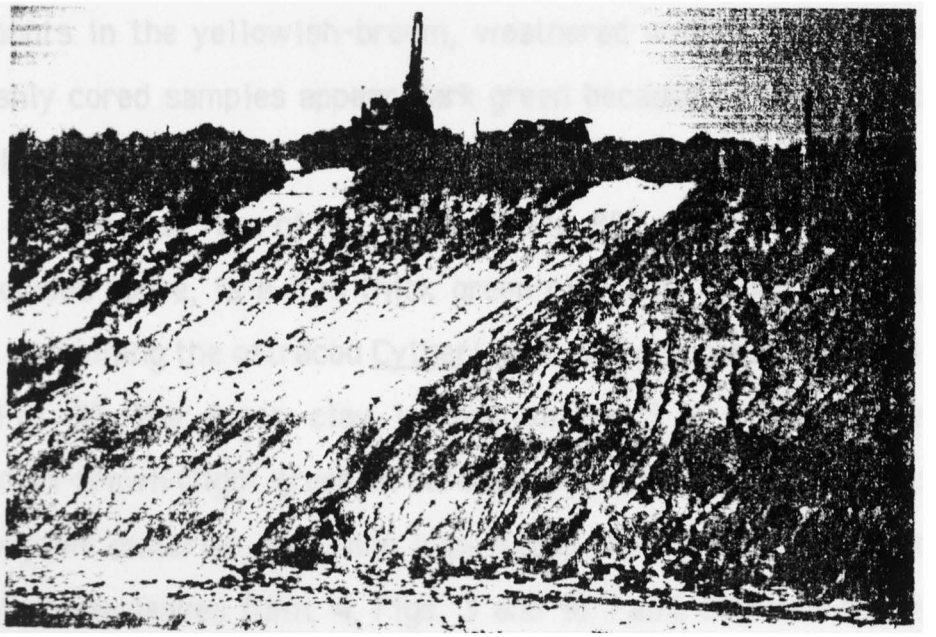
A



B

FIGURE 8. Laredo Formation beds exposed in the Lake Casa Blanca spillway. **A**. Laminated fine sand of Unit 2B in the southwestern corner of the spillway. Note figure at center-top of outcrop. **B**. Units 2B, 3, 4 and 5 exposed at the highest section on the east side of the spillway. The drill site is located at the top of this exposure.

A



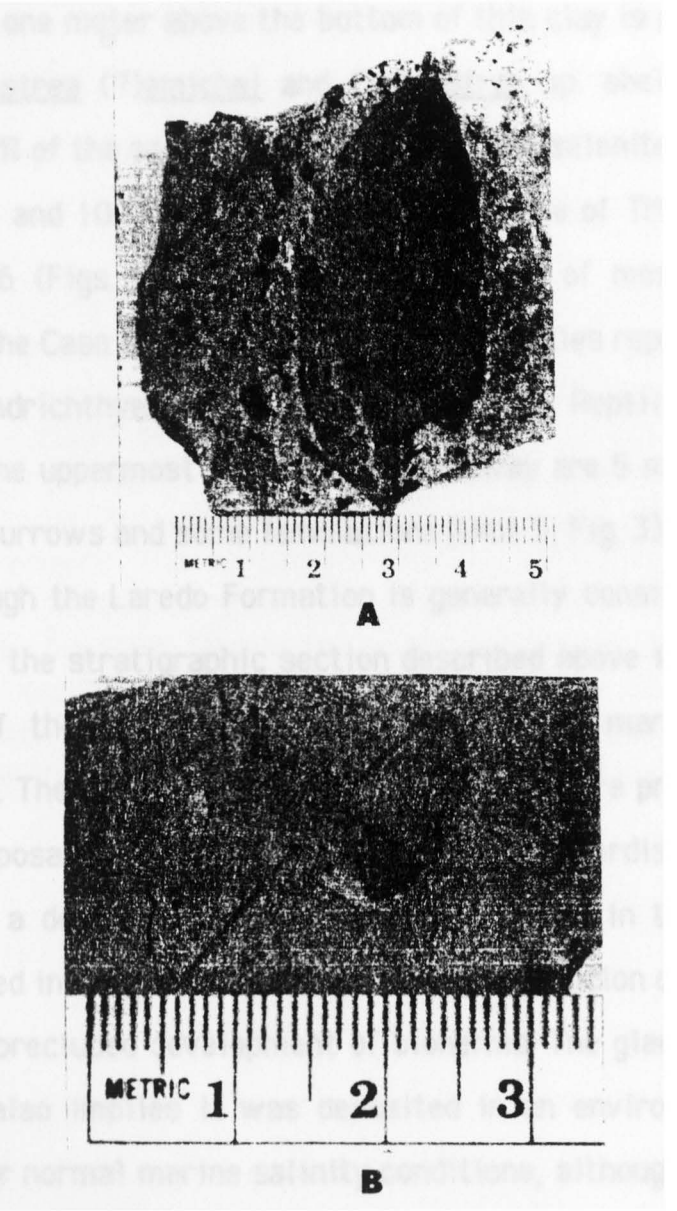
B

Horizontal, branching shrimp burrows (42582-3) greater than 6 cm in diameter are common in the muds below the oyster bioherm. The beds of Unit 2A may represent the uppermost level of the biohermal sands exposed below the dam in Unit 1. Additonal coring is needed to confirm this suggestion.

The stratigraphically highest beds of the sand sequence (Unit 2B) are thinly laminated (Fig. 8A) and except for small vertical burrows are almost non-fossiliferous, although a mandible of the artiodactyl Leptoreodon leptolophus was collected from these sands in 1976 (Wilson, 1984) from an unknown spot in the spillway (TMM locality 41871, Fig. 2). Glauconite pellets are present in small amounts in the yellowish-brown, weathered outcrop samples, while freshly cored samples appear dark green because of their glauconite content.

On the east face of the spillway (Fig. 8B) and overlying the sands described above, is a 3 m thick green clay with conchoidal fracture and containing the ostracod Cytherida sp. and glauconitic pellets (Unit 3, Fig. 3). The green clay is overlain by 5 m of thinly bedded, reddish-brown (light green in core samples), silty-clay which is rich in organic material, including logs, seeds and whole pteridophyte and angiosperm leaves (Unit 4, Figs. 3 and 9). Faint external molds of a pelecypod resembling the mussel Modiolus sp. are common in this clay. An ulna of Amynodon advenus reported by Wilson (1986:363), came from this clay where it is exposed at the north end of the

FIGURE 9. Angiosperm remains from Unit 4. **A**. An entire leaf. **B**. A fruit belonging to the genus Engelhardia.

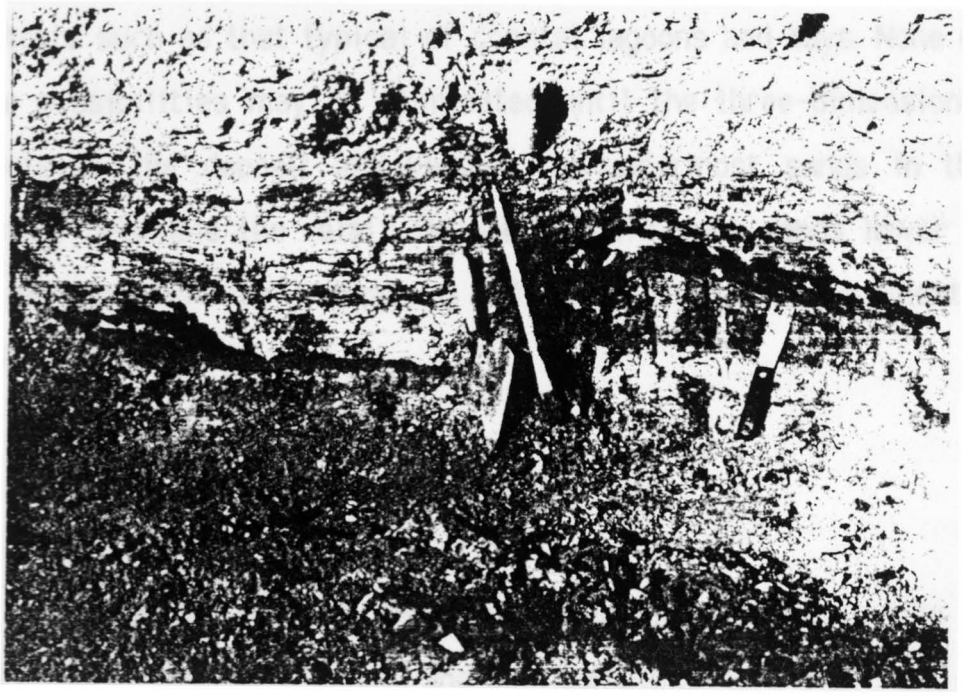

METRIC 1 2 3 4 5
A
METRIC 1 2 3
B

spillway (TMM locality 42185, Fig. 1). Near the south end of the spillway and one meter above the bottom of this clay is a lens of fine sand, Crassostrea (?)amichel and Cubitostrea sp. shellhash (often exceeding 50% of the sediment composition), and selenite gypsum, up to 1 m thick and 10 m long. This lens is the site of TMM vertebrate quarry 42486 (Figs. 2 and 10) and the source of most specimens comprising the Casa Blanca local fauna, with species representing the classes Chondrichthyes, Osteichthyes, Amphibia, Reptilia, Aves, and Mammalia. The uppermost strata in the spillway are 5 m of fine sand with small burrows and some laminations (Unit 5, Fig. 3).

Although the Laredo Formation is generally considered to be a marine unit, the stratigraphic section described above indicates that this part of the formation was deposited in a marginal marine environment. The Crassostrea amichel bioherms were probably living under the hyposaline conditions of an estuary or interdistributary bay adjacent to a delta. The absence of oyster reefs in the laminated sands exposed in the spillway indicates that deposition occurred more rapidly and precluded development of bioherms. The glauconite in the green clay also implies it was deposited in an environment having hyposaline or normal marine salinity conditions, although the absence of microfossils other than ostracods may indicate the presence of conditions lethal to other forms. The large amounts of plant material, especially the well preserved leaves, indicates that the reddish-brown clay was deposited under the influence of non-marine

FIGURE 10. Close-up views of portions of the Casa Blanca quarry (TMM fossil locality 42486). **A**. A fresh 1.5 m thick exposure in the mid-section of the quarry face. Beds above the upper brush are laminated muds; between the brushes is sandy oyster-shell hash rich in teeth, bones and lignite stringers; and between the lower brush and trowel are shell-bearing muds with some vertebrate remains. The vertebrate-bearing lens is nearly one meter thick. Note the shrinkage cracks in the weathered bentonite-bearing muds lateral to the fresh exposure. **B**. A fresh 0.3 m thick exposure on the northern edge of the quarry. The uppermost beds are laminated muds surrounding a lignitized log (right), while the lower log (left) is buried in shell-hash.

A



B

conditions in close proximity to living angiosperms. The water may have been brackish as the presence of the molds of ?Modiolus sp. only, appears to indicate conditions favorable to mussels, but no other molluscs. At the vertebrate quarry, the lens morphology, coarse grain size and faunal complement including terrestrial, freshwater, estuarine and marine forms implies that deposition may have occurred in an intertidal channel with relatively unrestricted access to those environments. The thickness of the channel fill ($^1/_2$ m) may indicate that channel incision and filling occurred on a microtidal coast. Alternatively, the shell-hash lens could be a storm washover deposit or offshore wave-built bar which accumulated on a muddy substrate such as that typical of coastal lagoons and bays. None of these possibilities may be eliminated until the three-dimensional aspects of the deposit are known. The uppermost sands in the spillway resemble the relatively non-fossilliferous sands lower in the section and may indicate a return to similar environmental conditions.

COLLECTION METHODS

Vertebrate remains were recovered using a combination of plaster jacketing (large bones) and bulk sampling. More than 5000 kg of sediment was collected as bulk sample by first removing the overburden from the site, then using small tools to excavate the

vertebrate bearing deposit in hopes of finding large bones. The shell-hash was stockpiled, then put in burlap bags and taken to Austin for screen-washing. Washed samples were then hand-picked for small teeth and bones.

Initially, samples were double-screened using a coarse steel screen with a mesh of 2 x 2/cm^2 (4 x 4/in^2) above window screen with a mesh of 7 x 6/cm^2 (18 x14/in^2). However, the presence of very small rodent incisors without correspondingly small rodent cheek teeth in the window screen fraction indicated an even smaller mesh screen was needed. A third screen composed of nylon and having a mesh of 11 x 7/cm^2 (26 x 17/in^2) was placed under the window screen, resulting in recovery of micro-rodent cheek teeth.

The screen-washing removed most fine sands and smaller grained sediments. However, a significant portion of the washed samples contained molluscan shell fragments ($CaCO_3$) and selenite gypsum ($CaSO_4 \cdot 2H_2O$). Washed samples were secondarily placed in a bath of 15% acetic acid and by the method described by Jeppsen, Fredholm and Mattiasson (1985) were leached of their $CaCO_3$ fraction. This reduced the window-screen fraction by about 60% and the nylon screen fraction by about 90%. Abundant (over 200) micro-rodent teeth were recovered from the fine acidized concentrate using a binocular microscope.

SYSTEMATIC PALEONTOLOGY

The use of the abbreviation "cf." in this section means "compare with" and follows the suggestions of Estes (1987:101).

Class Chondrichthyes

The taxonomy of Tertiary Chondrichthyans is in a state of confusion and flux. A thorough review of this group was recently made by Cappetta (1987), and will be followed here.

Order Lamniformes Berg, 1958
Family Odontaspidae Muller & Henle, 1839
Genus Striatolamia Gluckman, 1964

Striatolamia macrota (Agassiz, 1843)
(Fig. 11A)

Material- 42486-600, 23 lower and 36 upper teeth.

Discussion- This sand shark is represented by numerous, large teeth. The main cusp on the largest has a length of 29 mm from the enamel line on the root to the tip. The total height including the root is 39 mm. A tiny lateral denticle is present on either side of the median cusp on most of the teeth. Fine striae extend most of the lingual length of the main cusp. Some authors (Leriche, 1942;

FIGURE 11. Lower vertebrate remains from the Casa Blanca quarry. **A.** Striatolamia macrota tooth, anterior view, 42486-600; **B.** Carcharhinus sp. tooth, anterior view, 42486-603; **C.** Galeocerdo eaglesomei tooth, anterior view, 42486-601; **D.** Pristis sp. rostral tooth, 42486-604; **E.** Myliobatis sp. partial dental battery, view of roots, 42486-605; **F.** Rhinoptera sp. lateral tooth, view of roots, 42486-606; **G.** Lepisosteus sp. ganoid scale, external view, 42486-611; **H.** megalopid left dentary, lateral view, 42486-620; **I.** cf. Arius sp. left pectoral fin spine, dorsal view, 42486-613; **J.** Diaphyodus n. sp. left lower pharyngeal tooth plate, occlusal view, 42486-614; **K.** Diaphyodus n. sp. upper pharyngeal tooth plate, occlusal view, 42486-619; **L.** Jefitchia sp. juvenile otolith, 42486-575; **M.** cf. Allaeochelys sp. peripheral carapace element, dorsal view, 42486-622; **N.** Trionyx sp. pleural carapace element, dorsal view, 42486-623; **O.** Allognathosuchus sp. tooth, occlusal view, 42486-624; **P.** alligatorine cranium, dorsal view, 42486-643; **Q.** alligatorine dermal scute, dorsal view, 42486-625; **R.** crocodylid tooth, lateral view, 42486-627; **S.** Pristichampsus cf. P. vorax tooth, lateral view, 42486-626; **T.** cf. Glyptosaurus sp. dermal scute, dorsal view, 42486-630; **U.** Pterosphenus schucherti vertebra, anterior view, 42486-636; **V.** Pterosphenus schucherti vertebra, posterior view, 42486-635; **W.** Pterosphenus schucherti vertebra, right lateral view, 42486-631; **X.** avian femur, anterior view of distal end, 42486-641. **Y.** Scale for A-E, G-K, and M-X. **Z.** Scale for F and L.


A
B
C
D
E
F
G
H
I
J
K
L
M
N
O
P
Q
R
S
T
U
V
W
X
Y
10mm
Z
5mm

Thurmond and Jones, 1981:49) have attempted to discriminate between subspecies and varieties of S. macrota using characteristics of these striations. Considering the individual variation present in the teeth of modern sharks and the taxonomic confusion that exists in assignment of isolated shark teeth to the appropriate species, it seems unlikely that one can reliably recognize Eocene subspecies of sharks on the basis of teeth alone.

The taxonomic placement of S. macrota has been erratic. Most authors of this century have put S. macrota in the genus Odontaspis (Eastman, 1901:105; Leriche, 1942; White, 1956:147, 149; and Thurmond and Jones, 1981). Gibbes (1849:196) and Fowler (1911:51) reported occurrences of S. macrota under the name Lamna elegans.

S. macrota has been reported under various names from middle Eocene and older Paleogene deposits of New Jersey (Fowler, 1911; Leriche, 1942), Maryland and Virginia (Gibbes, 1849; Eastman, 1901; Leriche, 1942), South Carolina (Gibbes, 1849; Leriche, 1942), Alabama (Gibbes, 1849; Leriche, 1942; White, 1956:147, 149; Thurmond and Jones, 1981:47-49), Mississippi and Texas (Leriche, 1942).

Order Carcharhiniformes Compagno, 1973

Family Carcharhinidae Jordan & Everman, 1896

Genus Carcharhinus Blainville, 1816

Carcharhinus sp.

(Fig. 11B)

Material- 42486-603, 78 teeth.

Discussion- This genus of requiem sharks is represented by 78 teeth of which the largest is 11.5 mm wide with a total height of 9.7 mm. A survey of the literature on Tertiary sharks indicates that it has been difficult for workers to distinguish teeth of four carcharinid genera; Carcharhinus, Aprionodon, Hypoprion and Negaprion; from each other. Recent studies on living species of the first three genera indicate they are co-generic, with the latter two genera being synonyms of Carcharhinus (Compagno, 1979; 1984). Teeth of Negaprion also resemble those of Carcharhinus, however those of the former genus have serrations (if present) only at the base of the main cusp, while teeth of the latter may be serrated from the base to the tip of the cusp. Casa Blanca specimens display coarse to fine serrations at the cusp base with fine serrations present to the cusp tip, thus indicating affinity with Carcharhinus.

The genus Carcharhinus currently includes 29 living species of requiem sharks (Compagno, 1984:450). It is doubtful that isolated fossil teeth of Carcharhinus may be identified to species level

because of the combined factors of interspecific similarity and intraspecific variation observed in the teeth of living sharks belonging to the genus.

Genus Galeocerdo Muller & Henle, 1837

Galeocerdo eaglesomei White, 1955
(Fig. 11C)

Material- 42486-601, 319 lateral teeth; 42486-602, 25 symphyseal teeth.

Discussion- Teeth of this tiger shark are some of the most common fish remains found in the Casa Blanca quarry. Although smaller, the teeth are morphologically almost identical to specimens of G. eaglesomei from estuarine middle Eocene deposits exposed at Ameki, Nigeria and described by White (1926:26-29; 1955:25-26). White (1926:26) originally referred the Ameki tiger shark teeth to G. latidens, but later (1955:26) noted that their anterior margin is more convex, the posterior denticles reach nearer the tip, and the height relative to base length is greater, than in G. latidens.

The largest Casa Blanca specimen has a total height of 12 mm and a root length of18 mm. Another 25 teeth (42486-602) are nearly bilaterally symmmetrical and resemble symphyseal teeth of G. eaglesomi figured by White (1926). Teeth of G. eaglesomi are also known from middle Eocene deposits of Guinea Bissau, Tunisia; Togo;

and Qatar, Persian Gulf (Cappetta, 1987:123).

Order Batoidea

Family Pristidae

Genus Pristis Link, 1790

Pristis sp.

(Fig. 11D)

Material- 42486-604, 16 rostral teeth.

Discussion- A large species of sawfish is represented by rostral teeth. The largest measures 47 mm from base to tip, 10 mm antero-posteriorly at the base, and is 5 mm high at the base. Rostral teeth of Pristis are distinctive in lacking enamel and possessing a wide sulcus extending the length of the posterior edge. Reports of these elements from Eocene deposits of the Coastal Plain include the states of New Jersey (Fowler, 1911:82; Leriche, 1942:22-23), Virginia (Leriche, 1942: 22), North Carolina (Domning, Morgan and Ray, 1982:15), Georgia (Case, 1981:70), Alabama (White, 1956:128; Thurmond and Jones, 1981:72), Mississippi (Leriche, 1942:45), Louisiana (Glenk, 1934:349); Manning and Standhardt, 1986:147; McPherson and Manning, 1986:202), and Arkansas (Westgate, 1984:539).

Family Rhinobatidae

Genus Rhinobatos Link, 1790

Rhinobatos sp.

Material- 42486-607, tooth.

Discussion- This guitarfish is represented by a single tooth. The grinding surface of the specimen is approximately 2 mm across and the tooth including the root measures 2 mm in height. The rarity of this taxon is probably, in part, a result of the small size of its teeth.

The few Eocene locations on the Coastal Plain guitarfish teeth have been recognized include Twiggs County, Georgia (Case, 1981:68) and Montgomery Landing, Grant Parish, Louisiana (Manning and Standhardt, 1986:146).

Family Dasyatidae Jordan, 1888

Genus Dasyatis Rafinesque, 1810

Dasyatis sp.

Material- 42486-608, 3 teeth.

Discussion- Three minute teeth of the stingray Dasyatis sp. indicate these fish were present in the Casa Blanca estuary. Two teeth display the relatively flat oral surface typical of female stingray teeth. The oral surface of the smaller tooth measures 0.7 by

1.0 mm. The larger tooth measures 0.9 by 1.8 mm. The third tooth displays the trenchant morphology typical of male stingray teeth and the oral surface including the high ridge measures 1.2 by 1.2 mm. The paucity of fossil remains recovered at the Casa Blanca site may be the result of a combination of the small size of the teeth (discovery bias) and environmental conditions near the depositional site including in-life restriction of species distribution as well as taphonomic biases.

Dasyatis has also been reported from Eocene Coastal Plain deposits of Alabama (Thurmond and Jones, 1981:74) and Louisiana (Manning and Standhardt, 1986:145-146). Case (1981:68-69) correctly identified teeth of Dasyatis from the late Eocene of Georgia, but inexplicably referred to them as having belonged to clearnosed skates (Raja eglanteria).

Superfamily Myliobatoidea Compagno, 1973

Fragmentary pieces of the crushing pharyngeal teeth of eagle rays (42486-617) are ubiquitous in screen-washed concentrate from the Casa Blanca quarry. Because of the broken state of these teeth it is difficult to differentiate between those from the genus Myliobatis and those from Rhinoptera. Myliobatis possesses one very wide median (bilaterally symmetrical) tooth bounded by small, rhombohedral lateral teeth in each series in the dental battery. Rhinoptera displays five to seven distinctively wider-than-long median teeth,

the medio-lateral ones asymmetrical, with small rhombohedral teeth positioned on the extreme lateral edges. The presence of large myliobatid dental fragments (up to 8.1 mm in antero-posterior length) indicates that large eagle rays were present in the Casa Blanca fauna. A small tail-spine fragment, 2.8 mm wide (42486-618), is probably from a myliobatoid.

Family Myliobatidae Bonaparte, 1838

Genus Myliobatis Cuvier, 1817

Myliobatis sp.

(Fig. 11E)

Material- 42486-605, partial dental battery.

Discussion- One small partial dental battery is well enough preserved to identify as Myliobatis sp. This specimen possesses five fused median (symmetrical) teeth, three of which are nearly complete, and a rhombohedral tooth fused to the lateral margin of two of the median teeth. The largest median tooth is 12.4 mm wide and 2.7 mm long antero- posteriorly.

Reports of Eocene remains of Myliobatis throughout the Coastal Plain states include New Jersey (Fowler, 1911; Leriche, 1942); Maryland, Virginia and South Carolina (Eastman, 1901:98-101; Leriche, 1942); North Carolina (Domning, Morgan and Ray, 1982:16); Georgia (Case, 1981:72); Alabama (White, 1956:128; Thurmond and

Jones, 1981:76); Louisiana (Hopkins,1871:13; Manning and Standhardt,1986:147; McPherson and Manning, 1986:202); Arkansas (Westgate, 1984:539); and Texas (Manning and Standhardt, 1986:135).

Family Rhinopteridae Jordan & Everman, 1896

Genus Rhinoptera Cuvier, 1829

Rhinoptera sp.

(Fig. 11F)

Material- 42486-606, 10 lateral teeth.

Discussion- Ten complete widened and asymmmetrical myliobatid teeth are distinctive of the cow-nosed ray Rhinoptera. The largest specimen is 9 mm wide and 4.4 mm long. Gillette (1984:180) notes that in Rhinoptera these teeth are no more than three-times wider than the antero-posterior length.

Fossil Rhinoptera teeth have been reported from a few Eocene Coastal Plain deposits in North Carolina (Domning, Morgan and Ray, 1982:15-16), Georgia (Case, 1981:71); and Alabama (Thurmond and Jones, 1981:76). Fragmentary teeth of Rhinoptera may not be distinguishable from those of Myliobatis. It is likely that detailed study of many Eocene localities known to yield Myliobatis would produce teeth of Rhinoptera.

Chondrichthyes undet.

There are 84 vertebral centra from undetermined chondrichthyans (42486-609). Nearly all lack peripheral ornamentation and may not be identifiable at lower taxonomic levels. The centra range in size from 1.8 to 30.3 mm in diameter.

Class Osteichthyes

Infraclass Holostei

Order Semionotiformes

Family Lepisosteidae

Genus Lepisosteus Lacepede, 1803

Lepisosteus sp.

(Fig. 11G)

Material- 42486-611, 302 ganoid scales; 42486-610, 67 teeth; 42486-612, 22 opistocoelous vertebrae.

Discussion- Gar were common in the Casa Blanca fauna as evidenced by numerous scales, teeth and vertebrae. There are 302 thick, rhombohedral scales typical of Lepisosteus. The largest is 28 mm tall, 18 mm wide and 5 mm thick. At least 67 teeth (42486-610) display the conical shape, length-wise grooving and light-colored enamel cap characteristic of Lepisosteus. Additional specimens are assigned this number, but because of the broken nature of nearly all of these teeth, only those possessing an enamel tip were counted. The

largest tooth is also broken and exceeded 10 mm in length and 4 mm in diameter. There are 22 opistocoelous vertebrae referred to Lepisosteus sp.. The size of the centra of these vertebrae ranges from 5 to 21 mm in length, and 7 to 27 mm in width. Lepisosteus has been reported from Coastal Plain Eocene deposits of Maryland (Clark,1901:97-98), Alabama (Thurmond and Jones, 1981: 84), Louisiana (Hopkins,1870:92) and Arkansas (Westgate, 1984:539).

Infraclass Teleostei

Order Elopiformes Greenwood et al. (1966)

Family Megalopidae Jordan, 1923

Genus and species undet.

(Fig. 11H)

Material: 42486-620, 3 partial left and 3 partial right dentaries.

Discussion: Six partial dentaries belong to a large species of tarpon. The largest specimen is 33.4+ mm deep at the symphysis and has a dorsal surface bearing small teeth which is 3.9 mm wide.

Forey (1973) reviewed the fossil and recent members of the elopiform fishes and recognized two Eocene genera, Protarpon and Promegalops, both from the London Clay of Ypresian, early Eocene, age. Forey (1973) has shown that diagnostic differences between Protarpon, Promegalops, and the two modern meglopid genera, Tarpon and Megalops, primarily exist in cranial structures. The Casa Blanca specimens should not be referred to a genus of tarpon until well

preserved cranial remains have been found, athough they appear to represent the first Eocene record of the Megalopidae in North America.

Family Phyllodontidae

Genus cf. Paralbula Blake, 1940

cf. Paralbula marylandica Blake, 1940

Material- 42486-615, isolated crushing teeth.

Discussion- Numerous isolated crushing teeth of a phyllodont fish are hemispherical, smooth on the oral surface, and average roughly 1 mm in diameter. Paralbula maryandica possesses similar teeth. Blake (1940) based this species on a tooth plate from the Eocene Aquia Formation of Maryland. Detailed comparison of the Casa Blanca form must await discovery of complete tooth plates from the site.

Order Siluriformes

Family Ariidae

Genus cf. Arius Cuvier & Valenciennes, 1840

cf. Arius sp.

(Fig. 111)

Material- 42486-613, pectoral fin spines.

Discussion- Fragmentary pectoral fin spines of catfish are common

in the Casa Blanca quarry deposit. Complete specimens have not been recovered, but the spines generally resemble those of the modern sea catfish or hardhead, Arius felis, athough other catfishes may be represented. Pectoral fin spines of Arius felis differ from those of its close relative the gafftopsail catfish (Bagre marinus) by the presence of a single row of tooth-like serrations along the posterior edge of the spine of the former and a double row in the latter. The most complete Casa Blanca specimen lacks only the distal tip and is 72 mm long, and 14 mm wide at the proximal end. An even larger specimen is missing the proximal end and measures 95 mm in length. A count of 80 proximal ends of catfish fin spines provides some measure of the relative abundance of catfish in the Casa Blanca fauna. Late Eocene catfish fin spines referred to cf. Arius sp. are also known from Jackson Group deposits in St. Francis County, Arkansas (Westgate, 1984:539).

Family Sciaenidae

Genus Diaphyodus Schafhautl, 1863

Diaphyodus n. sp.

(Figs. 11J, K;12A)

Material- 42486-614, 2 lower pharyngeal tooth plates; 42486-619, 27 upper pharyngeal tooth plates.

Discussion- Two lower pharyngeal tooth plates (42486-614) closely

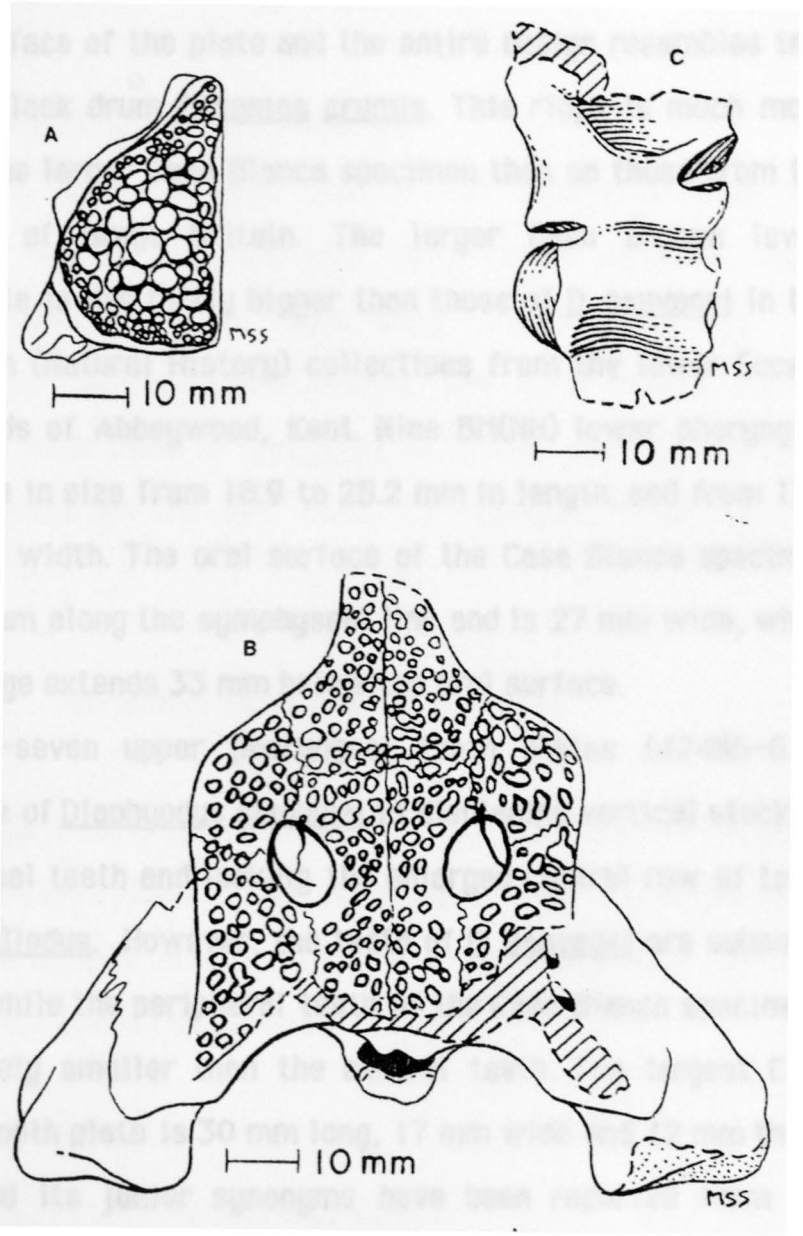


FIGURE 12. Lower vertebrates from the Casa Blanca quarry. **A.** Diaphyodus n. sp. occlusal view of left lower pharyngeal tooth plate, 42486-614. **B.** Alligatorine cranium in dorsal view, 42486-643. **C.** Pterosphenus schucherti thoracic vertebra, right lateral view, 42486-631.

resemble ones figured by White (1931:93) and referred to Diaphyodus sauvagei. As noted by White (1931:92), a ridge of bone is present on the ventral surface of the plate and the entire design resembles that of the living black drum Pogonias cromis. This ridge is much more trenchant on the larger Casa Blanca specimen than on those from the lower Eocene of Great Britain. The larger Casa Blanca lower pharyngeal plate is distinctly bigger than those of D. sauvagei in the British Museum (Natural History) collections from the lower Eocene Blackheath Beds of Abbeywood, Kent. Nine BM(NH) lower pharyngeal batteries range in size from 18.9 to 28.2 mm in length, and from 13.1 to 21.9 mm in width. The oral surface of the Casa Blanca specimen measures 38 mm along the symphyseal line and is 27 mm wide, while the ventral ridge extends 33 mm below the oral surface.

Twenty-seven upper pharyngeal tooth plates (42486-619) resemble those of Diaphyodus sauvagei in displaying vertical stacking of the individual teeth and lacking the enlarged central row of teeth present in Phyllodus. However, the teeth of D. sauvagei are subequal in diameter, while the peripheral teeth of the Casa Blanca specimens are distinctively smaller than the central teeth. The largest Casa Blanca upper tooth plate is 30 mm long, 17 mm wide and 12 mm thick. Diaphyodus and its junior synonyms have been reported from the Paleocene and Eocene of Europe (White, 1931:91), but is not previously known from North America.

Jefitchia sp.

(Fig. 11L)

Material- 42486-575, juvenile otolith.

Discussion- A single scianid otolith was recovered from the screen-washed sample. Undoubtedly many more otoliths were originally deposited, but apparently were removed by post-depositional carbonate dissolution. The Casa Blanca otolith compares well with those of Jefitchia sp. which has a middle and upper Eocene range on the Gulf Coast (G. Stringer, 1987, written comm.).

Infraclass Teleostei: family undet.

Four large skull fragments (42486-662) indicate the presence of very large teleost fish in the Casa Blanca fauna. These elements are comparable in size with those of the modern tarpon and may belong to the Casa Blanca megalopid.

Class Amphibia

Order Anura

Family undet.

Material- 42486-621, 2 proximal humeral fragments; 42486-663,

fragmentary ilium.

Discussion- Two small proximal humeral fragments and a fragment of ilium indicate the presence of frogs in the Casa Blanca fauna. The two humeral heads measure 0.7 and 1.1 mm in diameter. Additional material is needed to refine the taxonomic assignment of these specimens.

Class Reptilia

Order Chelonia

Over 10 kg of turtle shell fragments and skeletal elements are currently understudy by Dr. Howard Hutchison. There is a diverse chelonian component in the Casa Blanca fauna as indicated by the variety of shell morphologies. The depositional association with remains of vertebrate species representing a wide suite of habitats implies that an equally wide range in habitats may be represented by the chelonians. The following taxonomic assignments are primarily based on preliminary identifications by Dr. Hutchison (written commun., 1987).

Family Dermatemydidae

Genus cf. Baptemys Leidy, 1870

cf. Baptemys sp.

Material- 42486-647, shell elements.

Discussion- Shell material of this dermatemydid resembles that of Baptemys with some characters derived in the direction of Dermatemys, and is the youngest evidence of an American dermatemydid other than Dermatemys (Hutchison, 1987, written comm.).

Family Chelydridae

Subfamily Staurotypinae

Genus Xenochelys, Hay, 1906

Xenochelys (?) n. sp.

Material- 42486-648, shell elements.

Discussion- The presence of a species of Xenochelys in the Laredo Formation bridges a gap in the geologic record of the genus which formerly was known from Wasatchian, Bridgerian and Chadronian deposits of North America. The distribution of the two living staurotypine genera, Staurotypus and Claudius, is limited to Central America.

Emydidae

Genus and species undet.

Material- 42486-649, shell elements.

Discussion- A few shell fragments indicate that at least one species of emydid was a rare component of the Casa Blanca fauna. Modern emydids have a cosmopolitan distribution except for sub-Saharan Africa and Australia.

Family Testudinidae

Genus Hadrianus Cope, 1872

Hadrianus sp.

Material- 42486-650, shell elements.

Discussion- A few shell fragments evidence the presence of this large tortoise in the Casa Blanca fauna.

Superfamily Carrettochelyoidea

Family Carettochelyidae Boulenger, 1887

Genus cf. Allaeochelys Noulet, 1867

cf. Allaeochelys sp.

(Fig. 11M)

Material- 42486-622, shell elements.

Discussion- Numerous shell fragments possess the rugose surface typical of the shells of this family of highly aquatic turtles which have a fleshy shell covering similar to that of the Trionychidae, but have retained the peripheral bones. Allaeochelys is previously only known from the Eocene of Europe. Two other carettochelyid genera, Anosteira and Pseudanosteira are known from the Eocene of North America. The Casa Blanca carrettochelyid is the largest one known from the Americas (Hutchison, 1987, written comm.).

Family Trionychidae

Genus Trionyx Geoffrey, 1809

Trionyx sp.

(Fig. 11N)

Material- 42486-623, shell elements.

Discussion- Several costal and plastral elements belong to a softshell turtle (Trionyx sp.). Shell fragments of Trionyx are common in freshwater Eocene deposits of the continental interior. Westgate (1984:540) reported Trionyx sp. in a late Eocene estuarine deposit in St. Francis County, Arkansas. Trionyx is also known from the Aquia Formation of Virginia (Clark, 1896; Case, 1901:97-98).

Order Crocodilia

Family Crocodylidae Cuvier, 1807

Subfamily Alligatorinae Kalin, 1940

Genus Allognathosuchus Mook, 1921

Allognathosuchus sp.

(Fig. 110)

Material- 42486-624, 51 teeth.

Discussion- Isolated teeth of most crocodilians do not possess sufficient diagnostic characters for low level taxonomic assignment because of high species variability and general similarity within the group (Edmund, 1969; Malone, 1979:65). However, 51 teeth are distinctive in being extremely low crowned and flattened as are the posterior teeth in the alligatorine genus Allognathosuchus. The teeth range in size from 3.2 to 19.9 mm in maximum diameter and from 2.2 to 9.1 mm in height.

Alligatorine undet.

(Figs. 11P, Q; 12B)

A well preserved partial cranium (42486-643) belongs to an unidentified, medium-sized alligator. Additional skull material may prove this to be a previously unknown species.

A very large alligator is indicated by five dermal scutes

(42486-625). The two largest scutes are subrectangular and measure 45 and 36 mm in length, and 40 and 35 mm in width. The thickness at the keel is 19 mm in both, while the width of the keel halfway between its base and apex is 11 mm in the larger scute and 12 mm in the smaller.

Subfamily Pristichampsinae Kuhn, 1968

Genus Pristichampsus Gervais, 1853

Pristichampsus cf. P. vorax (Troxell, 1922)

(Fig. 11S)

Material- 42486-626, 28 teeth.

Discussion- Twenty-eight crocodilian teeth are distinctively laterally flattenned in the manner of the ziphodont crocodile Pristichampsus. Isolated teeth of this genus are probably not distinctive at the species level. However, the material likely represents the same species recently reported by Busby (1986) and referred to Pristichampsus cf. P. vorax. Those specimens come from relatively nearby deposits in Brewster County, Texas which are of slightly older age (early Uintan, middle Eocene). The Casa Blanca teeth range in size from 4.5 to 9.4 mm in length, 1.7 to 4.5 mm in width, and 4.4 to 17.9 mm in height.

The geographic and chronologic distribution of Pristichampsus in Eocene deposits of North America appears to be stratigraphically

and paleoecologically significant. It is found in Bridgerian age deposits in the Bridger and Washakie Basins (Langston, 1975) and in coastal southern California (Bramble and Hutchison, 1971). By Uintan time the geographic distribution of Pristichampsus appears to have been restricted to the southwestern U. S. and includes southern California (Bramble and Hutchison, 1971), west Texas (Busby, 1986) and is now recognized in the Rio Grande Embayment. The Casa Blanca Pristichampsus material represents the southernmost and one of the youngest occurrences of the genus in North America.

Crocodylidae: subfamily, genus and species undet.

Numerous isolated crocodile skeletal elements of undetermined taxonomic affinities indicate that crocodiles were a prolific part of the Casa Blanca fauna. Hundreds of typical conical crocodilian teeth are present. There are 91 relatively large teeth (42486-627). The largest is 39 mm tall and 24 mm in diameter (Fig. 11R). There are 343 small teeth (42486-628), of which the smallest tend to be laterally compressed rather than conical. Some teeth are less than 2 mm in height. There are also nine crocodilian vertebrae (42486-629) ranging from 12 to 51 mm in length.

Order Lacertilia

Family Anguidae

Genus cf. Glyptosaurus Marsh, 1871

cf. Glyptosaurus sp.

(Fig. 11T)

Material- 42486-630, 10 dermal plates.

Discussion- A lizard resembling Glyptosaurus sp. is represented by 10 subrectangular and beaded dermal plates. The largest plate measures 7.3 by 10.5 mm and is 2.2 mm thick at the low median ridge. The smallest plate measures 5.0 by 5.9 mm and is 1.3 mm thick. Gilmore (1928:94) recognized 10 Eocene and Oligocene species of Glyptosaurus in North America.

Order Serpentes

Family Palaeophidae

Genus Pterosphenus Lucas, 1898

Pterosphenus schucherti Lucas, 1898

(Figs. 11U, V, W; Table 2)

Material- 42486-631, -632, -633, -634, -635, -636, & -637, adult thoracic vertebrae; 42486-330, juvenile vertebra; 42486-638, -639, -640, fragmentary vertebrae.

Discussion- This giant aquatic snake is represented by at least seven isolated vertebrae. A tiny vertebra (42486-330) is apparently that of a juvenile snake and resembles a vertebra described by McPherson and Manning (1986:198-199) and referred to P. schucherti. An additional three vertebrae (42486-638, -639, and -640) are fragmentary and provisionally assigned to P. schucherti. Vertebrae of P. schucherti are distinctive in having a generally high and long shape with long aliform processes, two hypapophysial processes connected by a keel (on some), and prezygapophysial articular facets on the same plane as the floor of the neural canal (Gilmore, 1938:47; Holman, 1977:143). There is also a strong ridge extending from the accessory process to the base of the aliform process (Westgate, 1984:540-541) which is useful in distinguishing fragmentary vertebrae from those of the other palaeophid genus, Palaeophis.

Pterosphenus schucherti has been described from late Eocene deposits of numerous states including New Jersey (Miller, 1955), Georgia (Holman, 1977), Florida (Hutchison, 1985), Alabama (Lucas, 1898), Mississippi (Dessem, 1976; Westgate and Ward, 1981; Hutchison, 1985), Arkansas (Westgate and Ward, 1981; Westgate, 1984) and Louisiana (Dessem, 1976; Stringer, 1977; Breard, 1978; McPherson and Manning, 1986). P. schucherti has not previously been reported from middle Eocene deposits of North America. However, Andrews (1901, 1906:310-312) described an old world species, P. schweinfurthi, which is now known from the middle Eocene Birket Quarun Formation and the late Eocene Qasr el Sagha beds of Egypt

(Rage, 1984:36). Andrews (1906:311) noted that both P. schucherti and P. scheinfurthi are similar in the structure of their vertebrae, but felt those of the latter possess a significantly deeper posterior expansion of the neural arch, causing the free part of the lateral processes to be shorter. Hutchison (1985:21) noted that the basal walls of the pteropophyses of P. schweinfurthi are thicker than those of P. schucherti. Known remains of both species are primarily isolated vertebrae. Variation along the vertebral column, and individual and ontogenetic variation has not been well determined at this time. It is possible that P. schweinfurthi held a trans-Atlantic distribution during middle Eocene time and the Casa Blanca specimens really belong to that species. Additional specimens from the Casa Blanca site may indicate they represent a third and new species. However, the present sample of Casa Blanca Pterosphenus vertebrae are no different from the type of P. schucherti other than what can be attributed to individual or ontogenetic variation, or variation in the position in the vertebral column. For now it seems preferable to refer the Casa Blanca specimens to P. schucherti because of the proximity of its known geographic range to Texas, although previous records have been restricted to more easterlly and slightly younger deposits (primarily of the Jackson Group). The Casa Blanca discovery of Pterosphenus is the oldest record in North America, the first record of the genus in Texas, and the westernmost and southernmost occurrence of the genus in North America.

Table 2. Measurements (in mm) of vertebrae of Pterosphenus schucherti from TMM 42486.

Specimen #	Centrum length	Cotyle width	Condyle width
42486-330	1.8	1.0	0.4
42486-631	28.8	16.7+	15.3
42486-632	28.9	---	11.0+
42486-633	13.6+	16.2	14.3
42486-634	21.4	13.5+	12.5
42486-635	19.2+	---	12.3
42486-636	20.3	13.2	12.7
42486-637	16.4	8.0	7.5

Class Aves

Order undet.

(Fig. 11X)

The distal end of a femur (42486-641) is significant in being the sole representative of the Class Aves. The condyles are 9.9 mm wide and 21 mm of shaft is preserved. According to Dr. Storrs Olsen (written commun., 1986) it probably comes from a member of the basal waterbird assemblage, "i. e. the traditional orders Gruiformes, Charadriiformes, Ciconiiformes." The presence of this bone indicates

there is a good possibility of finding additional avian material in the Casa Blanca quarry. The rarity of bird bones in the deposit implies that taphonomic factors selected against their preservation, as there undoubtedly was a diverse avian fauna in the Casa Blanca biocoenose.

Class Mammalia

Subclass Metatheria

Order Marsupalia

Family Didelphidae Gray,1821

Subfamily Didelphinae Gray, 1821

Genus Peratherium Aymard, 1850

Krishtalka and Stucky (1983:231) recently reviewed the Paleocene and Eocene marsupials of North America and characterized the lower molars of Peratherium as having "a tall, spire-like entoconid, a lower, proximal and posterior hypoconulid, and a deep entoconid notch." Peratherium is restricted to Eocene deposits in North America and its five species from this continent, in order of decreasing size, are P. comstocki, P. edwardi, P. marsupium, P. knighti and P. innominatum (Krishtalka and Stucky, 1983:232).

Peratherium comstocki Cope, 1884

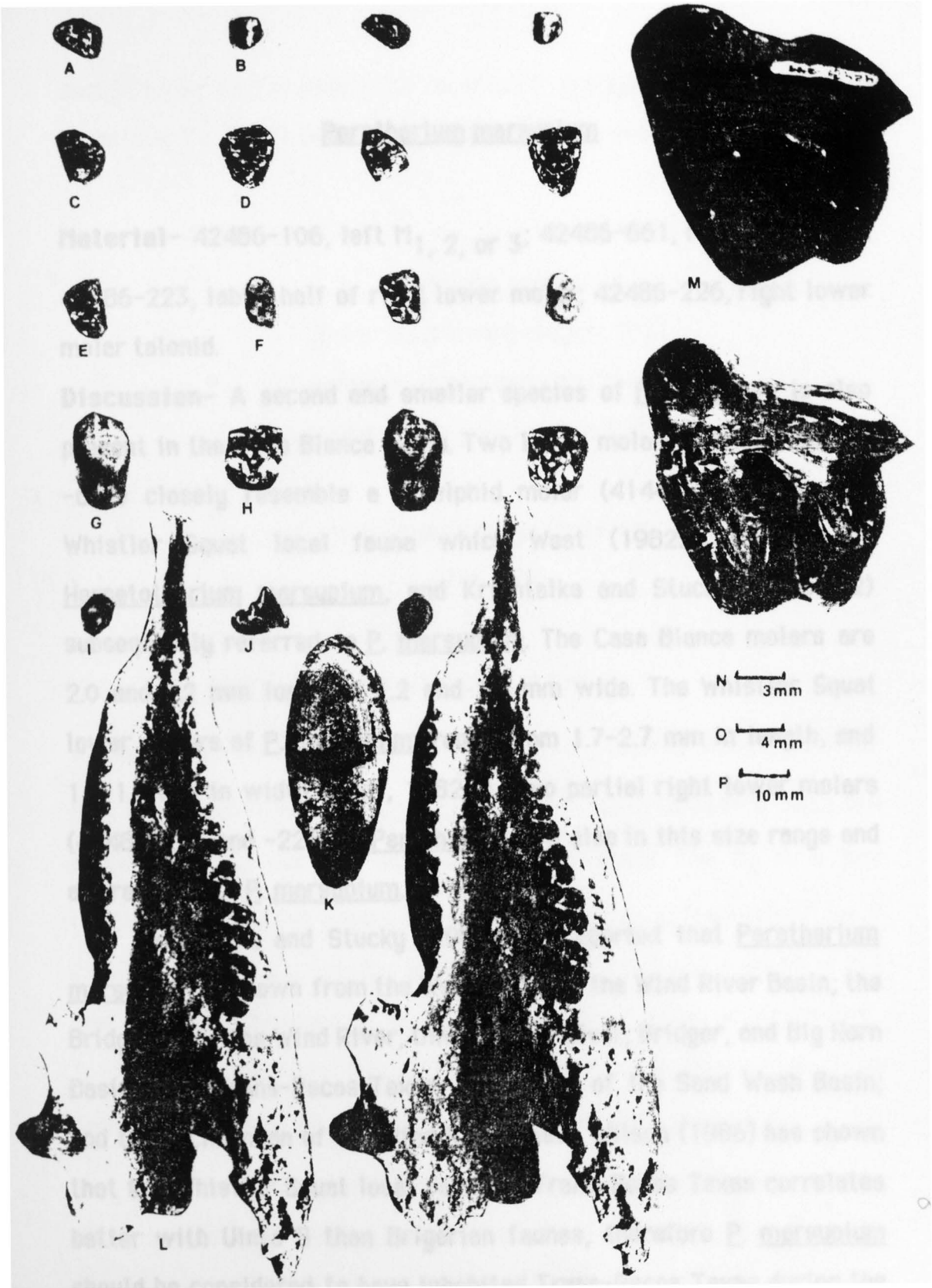
(Fig. 13A)

Material- 42486-117, right $M_{1, 2, or 3}$; 42486-211, lower right molar trigonid; 42486-218, lower right molar talonid.

Discussion- Peratherium comstocki is the largest North American species of Peratherium. A lower right molar (42486-117) from the Casa Blanca quarry resembles P. comstocki in both cusp morphology and size. The tooth is 3.4 mm long and 1.8 mm wide. The M_2 and M_3 of the type specimen of P. comstocki (AMNH 4252) are 3.15 and 3.25 mm long, and 1.9 and 1.7 mm wide, respectively (Krishtalka and Stucky, 1983). A lower right molar talonid (42486-218), 2.1 mm wide, and a right molar trigonid (42486-211), are also referred to P. comstocki.

Peratherium comstocki is known from the Wasatchian of the Big Horn, San Juan and Wind River Basins, and the Bridgerian of the ?Huerfano, Wind River and Bridger Basins (Krishtalka and Stucky, 1983:257). West (1982:2) referred didelphid specimens from the Whistler Squat local fauna of Brewster County, Texas to Herpetotherium cf. H. comstocki. Krishtalka and Stucky (1983:232) reassigned these specimens to P. comstocki, and noted they represent a range extension of the species to the latest Bridgerian and possibly the earliest Uintan. Wilson (1986) considered the Whistler Squat local fauna to be a Uinta B correlate and established the presence of P. comstocki in the Uintan fauna of Texas.

FIGURE 13. Stereo-photos (except J and K) of mammalian remains from the Casa Blanca quarry. **A.** Peratherium comstocki lower molar, occlusal view, 42486-117; **B.** cf. Simidectes magnus posterior half of left P_4, occlusal view, 42486-253; **C.** Omomys n. sp. left $M_{1 \text{ or } 2}$, occlusal view, 42486-165; **D.** Macrotarsius cf. M. jepsoni M^3, occlusal view, 42486-574; **E.** Microsyops sp. right $M^{1 \text{ or } 2}$, occlusal view, 42486-219; **F.** Microsyops sp. left $M_{1 \text{ or } 2}$, occlusal view, 42486-645; **G.** mesonychid $M_{3(?)}$, occlusal view, 42486-19; **H.** Hyopsodus cf. H. uintensis right $M^1(?)$, occlusal view, 42486-156; **I.** Uintacyon sp. left M^3, occlusal view, 42486-47; **J.** Procynodictis cf. P. vulpiceps right P_4, right lateral view, 42486-308; **K.** cross-section of a sirenian vertebral transverse process showing pachyosteosis and growth lines, 42486-506; **L.** Epihippus cf. E. gracilis mandible, occlusal view, 42486-220; **M.** Amynodon advenus left M^2, occlusal view, 42486-249. **N.** Scale for A, C-E. **O.** Scale for F and H. **P.** Scale for B, G and I-M.


A
B
C
D
E
F
G
H
I
J
K
L
M
N
3mm
O
4mm
P
10mm

Peratherium marsupium

Material- 42486-106, left $M_{1, 2, or 3}$; 42486-661, right $M_{1,2 or 3}$; 42486-223, labial half of right lower molar; 42486-226, right lower molar talonid.

Discussion- A second and smaller species of Peratherium is also present in the Casa Blanca fauna. Two lower molars (42486-105 and -661) closely resemble a didelphid molar (41443-189) from the Whistler Squat local fauna which West (1982:2) assigned to Herpetotherium marsupium, and Krishtalka and Stucky (1983:232) subsequently referred to P. marsupium. The Casa Blanca molars are 2.0 and 2.2 mm long and 1.2 and 1.4 mm wide. The Whistler Squat lower molars of P. marsupium range from 1.7-2.7 mm in length, and 1.0-1.4 mm in width (West, 1982:4). Two partial right lower molars (42486-223 and -226) of Peratherium are also in this size range and are referred to P. marsupium.

Krishtalka and Stucky (1983:257) reported that Peratherium marsupium is known from the Wasatchian of the Wind River Basin; the Bridgerian of the Wind River, Uinta, Green River, Bridger, and Big Horn Basins, and Trans-Pecos Texas; the Uintan of the Sand Wash Basin; and the Duchesnean of the Wind River Basin. Wilson (1986) has shown that the Whistler Squat local fauna of Trans-Pecos Texas correlates better with Uinta B than Brigerian faunas, therefore P. marsupium should be considered to have inhabited Trans-Pecos Texas during the

early Uintan. Storer (1984:16) recorded P. marsupium from a Uinta C correlate, the Swift Current Creek local fauna, in Saskatchewan.

Infraclass Eutheria

Order Insectivora Illiger, 1811

Superfamily Pantolestoidea Cope, 1887

Genus cf. Simidectes Stock, 1933

cf. Simidectes magnus (Peterson, 1919)

(Fig. 13B)

Material- 42486-253, posterior half of left P_4.

Discussion- This posterior half of a left P_4 (42486-253) resembles that of the pantolestid Simidectes magnus. The Casa Blanca tooth has a width of 4.6 mm and possesses an entoconid. The P_4 in a jaw (41580-11) from the Devil's Graveyard Formation of Brewster County, Texas referred to S. magnus by Gustafson (1979:4) has a width of 5.3 mm and also possesses an entoconid. A second species of Simidectes, S. merriami, is differentiated from S. magnus by the larger size of the former and lack of an entoconid on the P_4 (Gustafson, 1979:6).

Coombs (1971) reviewed the genus Simidectes and recognized a third species, S. medius which may be a synonym of S. magnus (Gustafson, 1979:6). The geographic and stratigraphic distribution of

S. magnus includes the Uinta Formation (Uinta B and C) of Utah (Gustafson, 1979:6), and the Devil's Graveyard Formation (Uinta C and early Duchesnean) of Trans-Pecos, Texas (Wilson, 1986:358). If S. medius is a synonym of S. magnus, the latter also may occur in the Mission Valley Formation (Uinta B) of southern California (Golz and Lillegraven, 1977:53).

Superfamily Soricoidea Fischer de Waldheim, 1817

Family Geolabidae McKenna, 1960

Genus Centetodon Marsh, 1872

Centetodon pulcher Marsh, 1872

Material- 42486-466 and -485, left $M_{1 \text{ or } 2}$; 42486-484, right $M_{1 \text{ or } 2}$; 42486-568, left $M_{1 \text{ or } 2}$ talonid; 42486-468, partial upper molar.

Discussion- Lillegraven et al. (1981) reviewed the Bridgerian and younger species of Centetodon and recognized eight species including, from oldest to youngest, C. pulcher, C. bembicophagus, C. aztecus, C. hendryi, C. magnus, C. chadronensis, C. marginalis and C. wolffi. Lillegraven and Tabrum (1983) described a new species, C. kuenzii, from middle Eocene and Oligocene deposits.

Three complete $M_{1 \text{ or } 2}$'s of Centetodon (42486-466, -484 and -485) were collected at the Casa Blanca quarry. These teeth are

1.9-2.0 mm long and 1.1-1.2 mm wide. Only C. pulcher and C. magnus have M_1 and $_2$'s of this length. The M_1 length (M_2 not known) in C. wolffi is larger at 2.53 mm [n=1] (Lillegraven et al., 1981:63). The combined ranges in M_1 and $_2$ length of the other Bridgerian and younger species of Centetodon are as follows: C. bembicophagus, 1.13-1.71 mm [n=41]; C. aztecus, 1.46-1.80 [n=25]; C. hendryi, 1.47-1.78 mm [n=13]; C. chadronensis, 1.38-1.86 [n=62]; C. marginalis, 1.51-1.89 [n=50]; and C. kuenzii, 1.38-1.81, [n=48] (Lillegraven, et al. 1981, Lillegraven and Tabrum, 1983). The Casa Blanca Centetodon lower molars also display cusp morphology similar to that described by Lillegraven et al. (1981) for C. pulcher and C. magnus.

The M^1 and ^{2} of C. pulcher and C. magnus may be differentiated by the presence of a single, lingual root which is round in cross-section in the former, and separated protoconal and hypoconal roots in the latter (Lillegraven et al., 1981). The only upper molar of Centetodon from the Casa Blanca quarry (42486-468) possesses the base of a broken single root which is round in cross-section. This upper molar is referred to C. pulcher and the lower molars discussed above are also assumed to represent that species.

Centetodon pulcher is previously known from the Bridger Formation of southwestern Wyoming (Lillegraven et al., 1981), and the Whistler Squat local fauna of Trans-Pecos Texas which is a Uinta B correlate (Wilson, 1986).

Order Primates

Suborder Plesitarsiiformes Gingerich, 1975

Infraorder Tarsiiformes Gregory, 1915

Family Omomyidae (Trouessart, 1879)

Genus Omomys Leidy, 1869

Omomys n. sp.

(Fig. 13C)

Material- 42486-40, -104, -165, -197, left $M_{1 \text{ or } 2}$; 42486-179, -245, -290, right $M_{1 \text{or } 2}$; 42486-118, -375, left P_4; 42486-379, right P_4.

Discussion- Gazin (1958) reviewed the Bridgerian members of the genus Omomys. He found Marsh's genera Euryacodon and Palaeacodon to be junior synonyms of Omomys, and recognized two species, O. carteri and O. lloydi (Gazin, 1958:48). Gazin (1958:50) considered Hemiacodon nanus, H. pucillus, Euryacodon lepidus and Palaeacodon vagus to be junior synonyms of O. carteri. Szalay (1976:260) agreed with Gazin's treatment of the Brigerian species of Omomys and provisionally included O. minutus in the genus, at least until additional material

might dispute that assignment.

Lillegraven (1980) reviewed the later Eocene primates from southern California. He found the specimens which Gazin used as the basis for the new genus and species, Stockia powayensis, to be very similar in morphology and size to O. carteri. Lillegraven (1980:190) considered Stockia to be a junior synonym of Omomys, and O. powayensis to have close affinity to O. carteri. West (1982:6) referred to the southern California species of Omomys as O. carteri.

A species of Omomys is represented by eight isolated M_1's or M_2's from the Casa Blanca quarry. The talonid basins on these molars are wide and deep as is typical of Omomys. The enamel surface in the talonid basins varies from smooth to rugose, with teeth displaying the least wear tending to have more rugose enamel. The cusp morphology resembles the "bulbous" type present on the M_{2-3} in a jaw fragment (41672-72) from the Purple Bench locality of the Serendipity local fauna of Trans-Pecos Texas which West (1982:6) described and referred to O. carteri. The M_2 of 41672-72 is 2.8 mm long and 2.6 mm wide. The Casa Blanca molars range in length from 3.2-3.6 mm [n=7], with a mean of 3.34 mm and a coefficient of variation of 4.84. Molar widths range from 2.5-3.0 mm [n=7], with a mean of 2.73 mm and a coefficient of variation of 7.24. A recently discovered jaw fragment (41672-199) of Omomys from the Purple Bench locality bears M_{1-2} which also display bulbous cusp

morphology. Both of those teeth are 3.7 mm long and 3.5 mm wide. The relatively large widths of the molars of 41672-199 include well developed cingula which extend the entire length of the labial side of the teeth. The cingula on the Casa Blanca molars are mainly restricted to the labial side of the trigonid.

Three omomyid P_4's (42486-118, -375 and -379) will provisionally be considered to belong to the same species of Omomys as the isolated molars discussed above, at least until a mandible possessing a P_4 and M_1 or M_2 is recovered. The lengths of the P_4's range from 2.4-2.8 mm with a mean of 2.57 mm, while their widths range from 2.0-2.1 mm with a mean of 2.03 mm.

The Casa Blanca Omomys compares most closely with O. carteri which is known from the Bridgerian of Wyoming and Utah (Gazin, 1958; Szalay, 1976), the early Uintan Friars and Mission Valley Formations of southern California (Lillegraven, 1980; West, 1982:6), and Uinta B and C stratigraphic correlates of Trans-Pecos Texas (West, 1982; Wilson, 1986). However, no known population of O. carteri displays M_1's or M_2's as large as those of the Casa Blanca or larger Purple Bench Omomys. The M_1's and M_2's of O. carteri from the Bridger beds range in length from 2.2-2.7 mm [n=24], and from 2.0-2.9 mm [n=21], respectively (Szalay, 1976:267). The same teeth of O. carteri from southern California range in length from 2.70-2.89 [n=2], and 2.50 mm [n=1] (Lillegraven, 1980:188). The M_1's of O. carteri from

Trans-Pecos Texas have a mean length of 2.56 mm [n=7] with a coefficient of variation of 1.12, while the M_2's in that population have a mean length of 2.68 mm [n=4] with a coefficient of variation of 2.39 (West, 1982:6). The lack of overlap in the lengths of the M_1 or M_2's of the Omomys from the Casa Blanca quarry and 41672-199 from Purple Bench, and those teeth from known populations of O. carteri, precludes referral of the Casa Blanca teeth and 41672-199 to that species. The close proximity of the Casa Blanca quarry to the Trans-Pecos Texas localities (450 km) limits the possibility that the differences in morphology and size between the Casa Blanca Omomys and the Trans-Pecos O. carteri are the result of clinal or subspecies variation, when the size equivalency of populations of O. carteri from regions as widespread as Trans-Pecos Texas, Wyoming, and southern California is considered.

It is likely that the bulbous teeth from the Casa Blanca and Purple Bench faunas represent a single species of Omomys. The differences in size and cingulum development observed in teeth from these localities may be an artifact of the small population sample.

Macrotarsius cf. M. jepseni (Robinson, 1968)

(Fig. 13D)

Material- 42486-574, M^3

Discussion- Szalay (1976) reviewed the genus Macrotarsius and

recognized two species, M. montanus and M. siegerti, noted that both species have the same tooth cusp morphology, and that the former species is the larger. Krishtalka (1978) added M. jepseni to the genus and based the species on the partial hypodigms of Hemiacodon jepseni (Robinson,1968) and Ourayia uintensis (Simons, 1961; Szalay, 1976). Krishtalka (1978:353) provided detailed descriptions of the upper molars of M. siegerti and M. jepseni, noting that they possess robust paracones and metacones, and broad protocones and trigon basins. The upper molar morphology in the two species differs only in the lack of a link between the mesostyle and the median flexure of the centrocrista in M. jepseni (Krishstalka, 1978:353). Lillegraven (1980: 195) noted the volatile taxonomic history of the holotype of M. jepseni (PU16431) as the specimen has been assigned to Microsyops, Omomys, Notharctus, Ourayia, Hemiacodon, and Mytonius by various workers.

An M^3 (42486-574) from the Casa Blanca quarry is 3.1 mm long, 4.2 mm wide, and has the cusp morphology characteristic of the upper molars of Macrotarsius. Krishtalka (1978:348) gave the range in the length and width of the M^3 of M. jepseni as 3.4-3.5 [n=2] and 4.6-4.7 [n=2], and the same measurements for M. siegerti as 3.0-3.7 [n=3], and 4.8-5.2 [n=4]. The Casa Blanca tooth lacks a connection between the mesostyle and the median flexure of the centrocrista and is tentatively referred to Macrotarsius cf. M. jepseni, although it is smaller than the M^3's in Krishtalka's hypodigm.

Macrotarsius siegerti is known from Uinton age deposits near

Badwater, Wyoming (Robinson, 1968). Krishtalka (1978:353) reported M. jepseni from the Uintan of Utah, and Lillegraven (1980:195) reported ?Macrotarsius sp. near M. jepseni from the early Uintan age Friars and Mission Valley Formations of San Diego County, California. West (1982:7) described Macrotarsius sp. from Uintan age deposits of the Pruett Formation [now Devil's Graveyard Formation, (Stevens, Stevens and Wilson, 1984)] and the Colmena Formation of Trans-Pecos Texas. Macrotarsius montanus is known from Chadronian deposits of Montana (Clark, 1941:562).

Family Microsyopidae Osborn and Wortman, 1892

Genus Microsyops Leidy, 1872

Microsyops sp.

(Fig.13E, F; 14A)

Material- 42486-51, left P^4; 42486-219, right $M^{1 \text{ or } 2}$; 42486-38, left $M^{1 \text{ or } 2}$; 42486-151, left P_4; 42486-175, $M_{1 \text{ or } 2}$; 42486-645, left $M_{1 \text{ or } 2}$; 42486-67, -167, -176, -337, -376, lower molar fragments.

Discussion- Szalay (1969) reviewed the Microsyopidae and synonomized Cynodontomys with Microsyops; and recognized nine species in the latter genus, including M. elegans, M. wilsoni, M. alfi, M. angustidens, M. latidens, M. scottianus, M. annectens, M. lundeliusi and

M. kratos. Microsyops has been reported from North American deposits ranging in age from earliest Wasatchian to earliest Uintan, with younger species displaying more molariform fourth premolars than the older forms (Szalay, 1969:248). Szalay (1969:273) stated that the molars of the various species of Microsyops are very similar and comparisons of isolated teeth in the absence of large populations may have no significance.

The Casa Blanca specimens referred to Microsyops are all isolated teeth. A broken P^4 (42486-51) is 3.3 mm wide, possesses two large labial cusps and a distinct posterior conule, and may have had an anterior conule prior to breaking. The degree of molarization of this tooth is consistent with the Bridgerian and younger species of Microsyops, M. elegans and M. annectens. The P^4 of M. kratos from the Uintan of southern California is not known.

A P_4 (42486-151) is 2.8 mm long and 2.1 mm wide. The size and morphology are similar to that of the P_4 of M. angustidens which Szalay (1969:257) describes as ranging from 2.7-3.3 mm in length and 1.9-2.2 mm in width.

Two $M^{1 \text{ or } 2}$'s (42486-219 and -38) are 3.0 and 2.9 mm long, 4.0 and 3.8 mm wide, possess paracones slightly smaller than metacones, have well developed paraconules and metaconules, and well developed hypocones, although these are smaller than the protocones. These molars are distinctly smaller than the size ranges of the M^1 and M^2 of M. annectens, M. elegans, M. lundeliusi, and M.

angustidens given by Szalay (1969), and smaller than the only upper tooth, an M^2, referred to M. kratos (Lillegraven, 1980:199). The Casa Blanca upper molars are slightly smaller than the M^1 and M^2 of M. latidens and M. alfi, and fit the size of the $M^1$and M^2 (length=2.5-3.0 mm, anterior width=2.85-3.9 mm) of M. wilsoni (Szalay, 1969).

Two Casa Blanca $M_{1 \text{ or } 2}$'s display species level differences in size. The larger (42486-645) is 4.4 mm long and 2.6 mm wide, while the smaller (42486-175) is 2.9 mm long and 1.5 mm wide. The smaller tooth is too worn for morphological comparison with known species of Microsyops. The larger tooth is similar in morphology and size to an undescribed Microsyops tooth (41745-182) from the Serendipity locality in Trans-Pecos Texas. West (1982:8) reported M. annectens from the nearby, but stratigraphically lower, deposits of the Whistler Squat local fauna. The Whistler Squat lower molars are larger than either the Casa Blanca or Serendipity specimens. The Serendipity and Casa Blanca Microsyops may have descended from the Whistler Squat species, may have migrated into Trans-Pecos Texas after Whistler Squat time, or may have been an as yet unrecognized co-inhabitant of Texas along with M. annectens. More complete specimens from either locality may give proof of a new species of Microsyops.

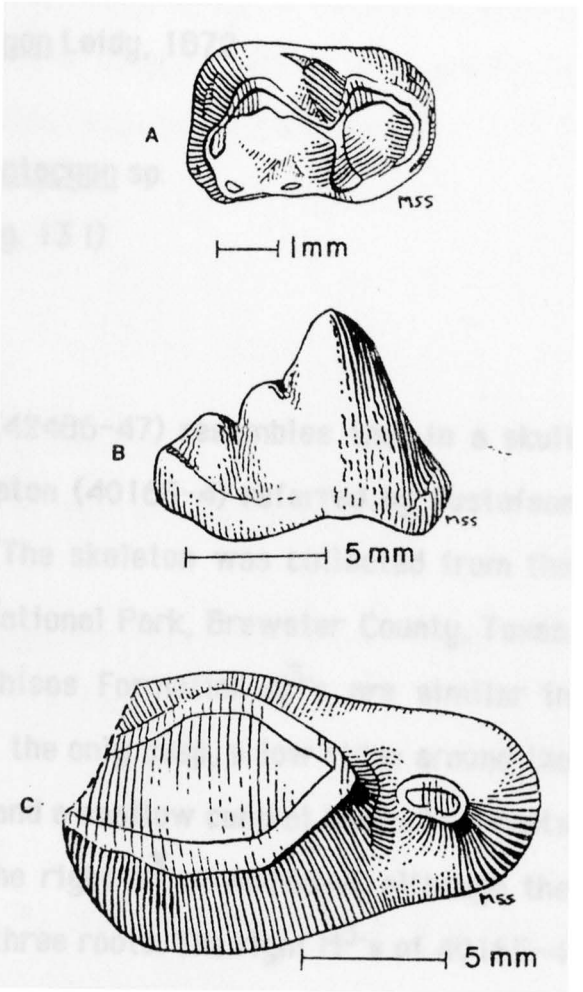


FIGURE 14. **A.** Microsyops sp. left $M_{1 \text{ or } 2}$, occlusal view, 42486-645. **B.** Procynodictis cf. P. vulpiceps right P_4, right lateral view, 42486-308. **C.** Mesonychid $M_{3(?)}$, occlusal view, 42486-19.

Order Carnivora Bowditch, 1821

Family Miacidae Cope, 1880

Genus Uintacyon Leidy, 1872

cf. Uintacyon sp.

(Fig. 13 I)

Material- 42486-47, left M^3.

Discussion- An isolated M^3 (42486-47) resembles that in a skull associated with a partial skeleton (40165-4) referred by Gustafson (1986:46) to Uintacyon scotti. The skeleton was collected from the Chisos Formation in Big Bend National Park, Brewster County, Texas. The Casa Blanca quarry and Chisos Formation M^3's are similar in displaying a small paracone as the only cusp, a low ridge around the peripheral margin of the tooth, and a shallow central basin. Two roots are present on 42486-47 and the right M^3 of 40165-4, although the left M^3 in that skull possesses three roots. The right M^3's of 40165-4 and 42486-47 are 4.8 and 6.0 mm long, and 6.3 and 5.5 mm wide, respectively. Uintacyon is known from the Bridgerian of Wyoming (Matthew, 1909), Uinta C of the Uinta Formation of Utah (Black and Dawson, 1966:336), Uintan deposits in Saskatchewan (Storer, 1984:55), and Uinta B and C equivalents in Trans-Pecos Texas (Wilson, 1986:358). It must be noted that Storer (1984:55) retained the original generic assignment of U. scotti and returned that species to Prodaphoenus. Storer (1984:55) also suggested that a mandible from

the Lapoint Member of the Duchesne River Formation may be referable to Prodaphoenus. Taxonomic revision of U. scotti is beyond to scope of this study and the recent generic assignments of the species by Gustafson (1986) and Wilson (1986) will be followed here.

Family Canidae

Genus Procynodictis Wortman and Matthew, 1899

Procynodictis cf. P. vulpiceps Wortman and Matthew, 1899

(Fig. 13J; 14B)

Material- 42486-308, right P_4.

Discussion- An isolated right P_4 (42486-308) displays characters distinctive of Procynodictis. Cusp terminology of P_4 here follows that of Flynn and Galiano (1982:4). Those authors (1982:57) synonymized "Plesiomiacis" (Stock, 1935) with Procynodictis. Both the P_4 of Procynodictis and 42486-308 lack a large anterior accessory cusp, but possess a large first posterior secondary cusp, a second posterior secondary cusp, and a posterior cingulum. Protictis aprophatos displays a cusp arrangement on P_4 similar to that of

Procynodictis (Flynn and Galiano, 1982:35). However, the former possesses a large anterior accessory cusp, lacks a cingulum, and is larger than Procynodictis (Flynn and Galiano, 1982:35).

The Casa Blanca P_4 possesses a rugose enamel surface and is 10.5 mm long and 3.9 mm wide. The P_4's of the type specimens of P. vulpiceps (AMNH 2514) and P. progressus (CIT 1776) have smooth enamel and are 8 mm and 6.5 mm long, and 3.5 mm and 3 mm wide, respectively. The Casa Banca Procynodictis more closely resembles P. vulpiceps in size, although the former is distinctly larger and possesses rugose enamel. Additional specimens of Procynodictis from the Casa Blanca quarry may provide statistical evidence that 42486-308 belongs to a new and larger species than P. vulpiceps.

Wortman and Matthew (1899) failed to give locality data for their type specimen of P. vulpiceps. Dawson (1980:86) stated that this specimen is from the "Diplacodon beds" and that two referred specimens (AMNH 1995 and 2506) are from basal Uinta C deposits of Utah. Dawson (1980:86) reported finding P. vulpiceps in the Uintan beds near Badwater Creek, Wyoming. Stock (1935) reported P. progressus from the lower Sespe Formation of Ventura County, California. This part of the Sespe Formation is considered to be a Uinta C equivalent (Golz and Lillegraven, 1977:50).

Order Condylarthra Cope, 1881

Family Mesonychidae Cope, 1875

Genus and species undet.

(Fig. 13G; 14C)

Material- 42486-18, M_3(?); 42486-19, incisor.

Discussion- A posterior lower molar (42486-18) resembles the M_3 in the type specimen of Harpagolestes uintensis (PU 11659). The Casa Blanca tooth is 16.6 mm long and 9.9 mm wide. The M_3 of PU 11659 is 15.7 mm long and 8.9 mm wide. Both teeth display strong occlusal wear. Additional mesonychid material may prove that Harpagolestes was a member of the Casa Blanca fauna, however 42486-18 provides insufficient evidence to allow generic identification. A large incisor (42486-19) is the size, 9.2 mm long and 6.0 mm wide, and shape of those of H. uintensis. This tooth is provisionally referred to the Mesonychidae as there are no other large carnivorous forms presently recognized in the Casa Blanca fauna.

Bridgerian species of Harpagolestes are known from Wyoming. Harpagolestes uintensis is reported from deposits of Uintan age in Utah and Wyoming. Gustafson (1986:8) referred a lower jaw from a Uinta C equivalent, the Candelaria local fauna of Presidio County, Texas, to cf. Harpagolestes uintensis. The Friars Formation of the San Diego, California area has yielded cf. Harpagolestes sp. in association

with an early Uintan fauna (Golz and Lillegraven, 1977). Harpagolestes sp. is known from a Uinta C equivalent, the Swift Current Creek local fauna of Saskatchewan, Canada (Storer, 1984:60), and early Duchesnean deposits of Brewster County, Texas (Gustafson, 1986:8).

Family Hyopsodontidae Trouessart, 1879

Genus Hyopsodus, Leidy, 1870

Hyopsodus cf. H. uintensis Osborn, 1902

(Fig. 13H)

Material- 42486-156, right $M^{1?}$; 42486-244, left $M_{1 \text{ or } 2}$; 42486-311, left M_3.

Discussion- Gazin (1968) reviewed the genus Hyopsodus and recognized two Uintan species, H. uintensis and H. fastigatus. Krishtalka (1979) reviewed the Uintan and Duchesnean species of Hyopsodus and recognized H. paulus in Uinta B deposits, H. uintensis in Uinta C and its correlatives, and H. sholemi in Montana deposits of Duchesnean age. West (1982) accepted Krishtalka's (1979) diagnoses of H. paulus and H. uintensis from Uintan deposits in the Rocky Mountains. Storer (1984) resurrected H. fastigatus based on an enlarged sample of teeth from Swift Current Creek, Saskatchewan.

Three teeth from the Casa Blanca quarry are referred to Hyopsodus cf. H. uintensis. A right $M^{1?}$ (42486-156) is 4.3 mm long,

4.5 mm wide, and possesses a hypocone nearly as large as the protocone, with a lingual valley separating those cusps and extending labially to the metaconule. This size is close to the range of the M^1's of H. uintensis reported by Krishtalka (1979:383). The morphology of 42486-156 is characteristic of the M^1 of H. uintensis which is distinguished from that of H. paulus by the traits described above (Kristalka, 1979:382; West, 1982:10). The conules are not large and crescentic as is characteristic of those on the M^1 of H. fastigatus (Storer, 1984:62). A left $M_{1 \text{ or } 2}$ (42486-244) and a left M_3 (42486-311) measure 4.3 and 4.5 mm in length. The width of the first is indeterminate because of breakage, while that of the M_3 is 2.9 mm. Both teeth display nearly joined entoconids and hypoconulids. This feature distinguishes H. uintensis from H. paulus (West, 1982:10). The trigonids of the Casa Blanca teeth do not display the oblique condition found in lower molars of H. fastigatus (Storer, 1984:62). The small size of these teeth resembles that of Hyopsodus teeth from Trans-Pecos Texas which West (1982:11) referred to Hyopsodus cf. H. uintensis.

Hyopsodus uintensis is known from late Uintan deposits in the Rocky Mountains of Utah and Wyoming. It is also reported from the Whistler Squat and Serendipity local faunas of Trans-Pecos Texas (Wilson, 1986:372).

Order Sirenia

Family, genus and species undetermined

(Fig. 13K)

Material- 42486-506, transverse process from a lumbar or anterior caudal vertebra.

Discussion- A transverse process from a lumbar or anterior caudal vertebra (42486-506) displays the pachyosteotic condition typical of sirenians and archaeocete whales. Comparison of 42486-506 with sirenian and archaeocete vertebrae indicates a greater similarity to the former in both the robustness and curvature of the transverse processes. The process measures 32.9 mm in antero-posterior length at the constriction near the origin at the centrum and is 23.0 mm thick at that point; 42.2 mm in antero-posterior length at the distal end; and 94.1 mm in transverse width from the base to the distal edge.

There are four other occurrences of sirenians in the Laredo Formation. Domning, Morgan and Ray (1982:8) reported the discovery around 1950 of a partially articulated sirenian vertebral column and rib cage (41843-1) in the "Cook Mountain" [=Laredo] Formation near Falcon Dam. They gave the location as 0.8-1.6 km upstream of the dam, in Zapata County (Domning, Morgan and Ray, 1982:8). The U.S.G.S. Falcon Village, Tex. 7.5' topographic quadrangle map (1965) shows that the Zapata County line comes no closer than 1.4 km to Falcon Dam

and the locality description given by Domning, Morgan and Ray (1982) primarily lies in Starr County.

Six sirenian ribs were collected by Dr. C. Gee and the writer in May, 1985, from the south bank of Dolores Creek, 0.3 km southwest of where the creek crosses the 340 ft contour line indicated on the U.S.G.S. Blancas Creek South, Tex. 7.5' topographic quadrangle map (1980). This section of Dolores Creek lies near the mapped contact of the Laredo and Yegua Formations on the Geologic Atlas of Texas, Laredo Sheet (1976). The sirenian locality falls in the area mapped as upper Laredo Formation. This site is on the 3-D ranch in extreme northwestern Zapata County, 3.8 km southwest of the Webb County line.

One rib (42985-1) was at creek level, four ribs (42985-2) were lying 1/3 m above creek level, and one rib (42985-3) was 1.5 m above creek level. The bones were buried in laminated fine sands containing small bioherms of Crassostrea sp.. The stratigraphic position of the ribs indicates that at least three individuals are probably represented.

The thorough review of North American Eocene sirenians by Domning, Morgan and Ray (1982) indicates the Laredo Formation sirenians are the only Eocene sea cow specimens from Gulf Coastal Plain deposits west of Alabama. Taxonomic assignment of these specimens below the ordinal level must await the discovery of more diagnostic material.

Order Perissodactyla

Family Equidae Gray, 1821

Genus Epihippus Marsh, 1877

Epihippus cf. E. gracilis (Marsh, 1871)

(Figs.13L; 15, Table 3)

Material- 42486-220, nearly complete mandible with left and right rami and left and right P_3-M_3; 42486-310, partial left M_3; 42486-504, partial M_3; 42486-59, lower molar fragment; 42486-329, lower molar fragment; 42486-53, three upper right molars (M^{1-3}?); 42486-255, upper left molar; 42486-343, upper left molar; 42486-46, upper right molar fragment; 42486-505, upper right molar fragment; 42486-54 and 42486-85, astragali.

Discussion- Epihippus is distinguished from the similar genus Orohippus by the presence of a single-rooted P_1 in the former and double-rooted P_1 in the latter (Peterson, 1931:67; MacFadden, 1976:11), and more molariform P_2's in Epihippus (MacFadden, 1976:11). The Casa Blanca mandible (42486-220) possesses single-rooted alveoli for P_1 and is assigned to Epihippus. The other Casa Blanca equid specimens are also assigned to Epihippus, as the genus is not known to occur with other equid genera.

MacFadden (1980) reviewed the species of Epihippus and found

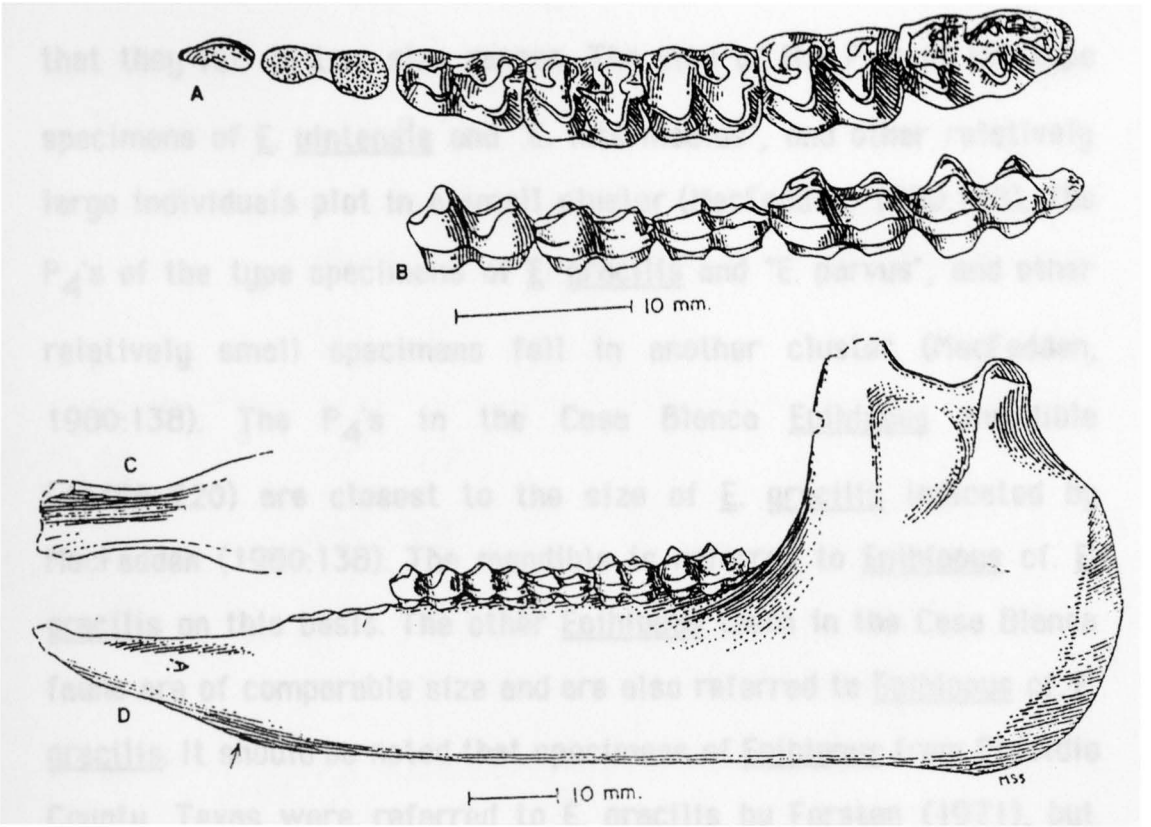


FIGURE 15. Epihippus cf. E. gracilis mandible with left and right P_3-M_3, 42486-220. **A.** Occlusal view of left cheek teeth, P1 and 2 alveoli based on right ramus alveoli. **B.** Labial view of left cheek teeth. **C.** Dorsal view of symphysis. **D.** Left lateral view of mandible. Arrow indicates proximal extent of symphysis.

that they fall in two size ranges. The size of the P_4's of the type specimens of E. uintensis and "E. intermedius", and other relatively large individuals plot in a small cluster (MacFadden, 1980:138). The P_4's of the type specimens of E. gracilis and "E. parvus", and other relatively small specimens fall in another cluster (MacFadden, 1980:138). The P_4's in the Casa Blanca Epihippus mandible (42486-220) are closest to the size of E. gracilis indicated by MacFadden (1980:138). The mandible is referred to Epihippus cf. E. gracilis on this basis. The other Epihippus teeth in the Casa Blanca fauna are of comparable size and are also referred to Epihippus cf. E. gracilis. It should be noted that specimens of Epihippus from Presidio County, Texas were referred to E. gracilis by Forsten (1971), but those specimens plot in the size range of E. uintensis of MacFadden (1980), and were referred to E. uintensis by Wilson (1986:373). The Presidio County and Laredo Epihippus P_4's cluster together in a group whose tooth-size is slightly larger than those in the E. gracilis hypodigm of MacFadden (1980) and overlap onto the small end of his hypodigm for E. uintensis.

Additional material from Texas may indicate that the Texas Epihippus was a large southern variant of E. gracilis as Forsten (1971:3) claimed; the Texas Epihippus was a small southern variant of E. uintensis; or a third species of Epihippus of intermediate size lived in Texas.

Table 3. Measurements (mm) of Epihippus gracilis in the Casa Blanca fauna.

	42486-220		42486-53A	42486-255	42486-343
	LT	RT			
P_3 AP	7.0	7.2			
W	4.2	4.4			
P_4 AP	6.7	6.6			
W	5.1	5.1			
M_1 AP	7.6	7.6			
W	5.7	5.8			
M_2 AP	8.0	8.1			
W	6.2	6.2			
M_3 AP	9.6	9.8			
W	5.6	5.5			
Mand. length	126.3	--			
Mand. depth at M_3	19.1	19.8			
$M^{1 \text{ or } 2}$ AP			9.1	7.8+	7.9
W			8.9	8.9	9.5

Epihippus occurs in strata as old as the Wagonhound Member of the Uinta Formation and its stratigraphic equivalents and as young as the Halfway Member of the Duchesne River Formation and its equivalents, in Utah, Wyoming, Texas, and Saskatchewan (Black and Dawson, 1966; MacFadden, 1980; Storer, 1984; and Wilson, 1986). Bjork (1967) reported "E. intermedius" [=E. uintensis] from the Antelope Creek local fauna of northwestern South Dakota of undifferentiated Duchesnean age.

Superfamily Rhinocerotoidea Gill, 1872

Family Amynodontidae Scott & Osborn, 1883

Genus Amynodon Marsh, 1877

Amynodon advenus (Marsh, 1875)

(Figs. 13M; 16)

Material- 42486-249, left M^2; 42486-207, incisor; 42486-208, incisor; and 42486-91, fragmentary upper molar; 42185-1, ulna.

Discussion- A complete rhinoceros M^2 is referred to Amynodon advenus. Wilson and Schiebout (1981) recently described a large population of A. advenus from the Whistler Squat local fauna of Trans-Pecos Texas. Their statistical analysis allowed them to conclude that A. advenus and A. reedi were the only species of

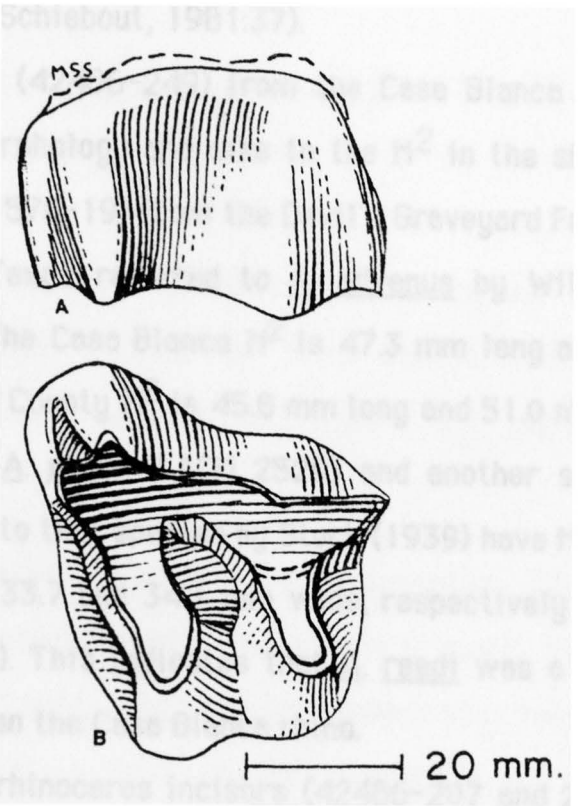


FIGURE 16. Amynodon advenus left M^2, 42486-249. **A**. Labial view. **B**. Occlusal view.

Amynodon inhabiting the western United States during Uintan time, and that "A. antiquus, A. intermedius and A. erectus" are synonyms of A. advenus (Wilson and Schiebout, 1981:37).

The upper molar (42486-249) from the Casa Blanca fauna is almost identical in morphology and size to the M^2 in the skull of a (?female) specimen (41576-19) from the Devil's Graveyard Formation of Brewster County, Texas referred to A. advenus by Wilson and Schiebout (1981:11). The Casa Blanca M^2 is 47.3 mm long and 51.1 mm wide. The Brewster County M^2 is 45.8 mm long and 51.0 mm wide. The type specimen of A. reedi (LACM 2529) and another specimen (AMNH 1936A) referred to that species by Stock (1939) have M^2's 29.5 and 29.7 mm long, and 33.7 and 34.1 mm wide, respectively (Wilson and Schiebout, 1981:30). This indicates that A. reedi was a smaller species of Amynodon than the Casa Blanca rhino.

Two well-worn rhinoceros incisors (42486-207 and 208) are also referred to A. advenus. They have crowns which are 10.0 and 10.1 mm long antero-posteriorly, and are 8.2 and 9.8 mm wide. A fragmentary upper molar (42486-91) cannot be measured but is assumed to also be from A. advenus. Wilson (1986:363) reported the discovery of an ulna of A. advenus (42185-1) in deposits in the Lake Casa Blanca spillway. The dental material from the Casa Blanca quarry verifies his taxonomic assignment.

Amynodon advenus occurs in deposits ranging in age from Uinta A to C and has been found in Utah, Wyoming, California and Texas (Wilson and Schiebout, 1981).

Family Brontotheriidae

Genus and species undetermined

(Figs. 17A, B)

Material- 42486-89, canine; 42486-294, milk incisor or milk canine; 42486-503, milk incisor or milk canine; 42486-359, fragmentary lower molar; 42486-110, worn P_2; 42486-502, posterior fragment of M_3.

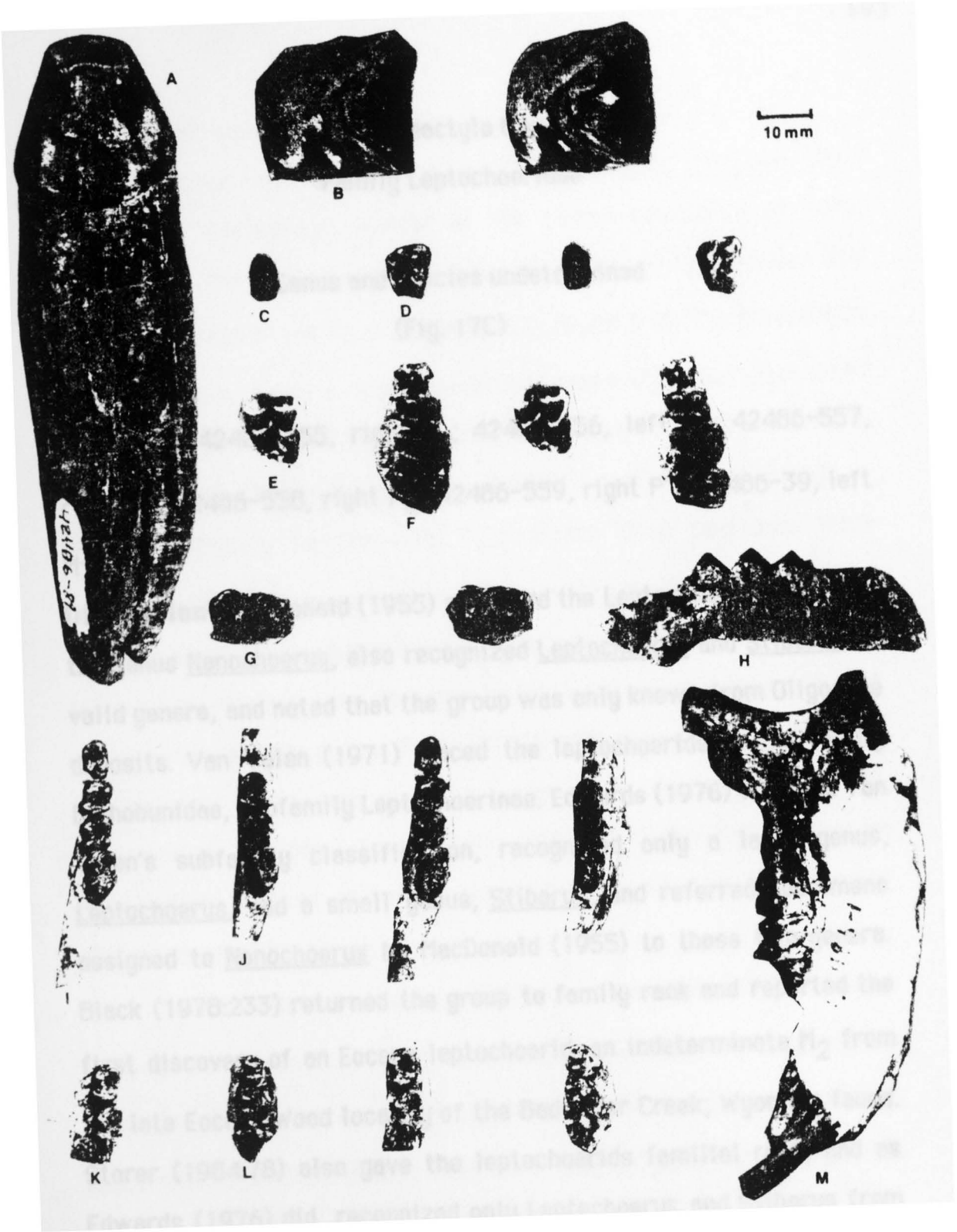
Discussion- Identification of isolated or fragmentary titanothere teeth in the absence of more complete specimens probably should not be attempted below the family level. The titanothere specimens in the Casa Blanca quarry indicate a large species inhabited the Laredo area at the time of deposition of the Laredo Formation. A titanothere of similar size, Notiotitanops mississippiensis (Gazin and Sullivan, 1942), is known from Mississippi's stratigraphic equivalent of the Laredo Formation, the Cook Mountain Formation. Wilson (1977) based a new species, Sthenodectes australis, on specimens from the Whistler Squat and "probably" the Candelaria local faunas of Trans-Pecos, Texas. He noted (Wilson, 1977:13) very close similarity in size between S. australis and N. mississippiensis.

A fragmentary lower molar from the Lake Casa Blanca spillway (42486-359) is 26.5 mm wide, while the M_1's of the type specimen of

N. mississippiensis (USNM 16646) and of a lower jaw (41715-6) referred by Wilson (1977:4) to S. australis, are 26.7 and 25.0 mm wide, respectively. A titanothere canine from the Casa Blanca quarry is 29.8 mm long, 27.6 mm wide and has a root length of 81.3 mm. The canines from the type specimens of N. mississippiensis and S. australis (41723-3) are 27 and 28.5 mm long, and 24 and 28 mm wide, respectively.

Two milk incisors or milk canines (42486-294, -503) from the Casa Blanca quarry cannot be compared with described specimens of N. mississippiensis or S. australis because of the absence of deciduous teeth in those specimens. However, the Webb County teeth are nearly identical to a deciduous incisor and a deciduous canine in the mandible of a juvenile titanothere (41916-8) from the lower Chisos Formation of Big Bend National Park, Brewster County, Texas. The Casa Blanca deciduous incisors (42486-294 and 503) are 6.5 and 6.4 mm long, and 6.2 and 6.8 mm wide, respectively. Both are cylindrical with slight lingual, shelf-like cusps. A dimple in the enamel is present on the labial surface at the level of the lingual cusp in 42486-503. The deciduous incisor and deciduous canine in 41916-8 are 6.8 and 6.4 mm long, and 6.1 and 6.5 mm wide, respectively. The deciduous incisor displays a slight lingual cingulum and a labial dimple in the enamel similar to that of 42486-503.

FIGURE 17. Stereo-photos (except A, H and M) of mammalian remains from the Casa Blanca quarry. **A.** titanothere canine, lingual view, 42486-89; **B.** titanothere fragmentary lower molar, occlusal view, 42486-359; **C.** leptochoerid P_4, occlusal view, 42486-555; **D.** Protoreodon petersoni right M^1; occlusal view, 42486-222; **E.** Leptoreodon pusillus right M^1, occlusal view, 42486-224; **F.** Leptoreodon leptolophus left maxilla with P^4-M^3, occlusal view, 42486-571; **G.** Toromeryx cf. T. marginensis labial half of upper molar, occlusal view, 42486-490; **H.** Toromeryx cf. T. marginensis left mandibular ramus with P_1 alveous and P_{2-4}, left lateral view, 42486-164; **I.** Mytonomys cf. M. robustus left mandibuar ramus with P_4-M_3, occlusal view, 42486-278; **J.** Mytonomys cf. M. robustus left mandible with M_{1-3}, occlusal view, 42486-277; **K.** Mytonomys cf. M. robustus, left M_{2-3} in nearly complete mandible, occlusal view, 42486-1; **L.** Mytonomys cf. M. robustus right maxillary fragment with M^{1-3}, occlusal view, 42486-573; **M.** Mytonomys cf. M. robustus left mandible with incisor and M_{2-3}, left lateral view, 42486-1.


A
B
10 mm
C
D
E
F
G
H
I
J
K
L
M

Order Artiodactyla Owen, 1848

Family Leptochoeridae

Genus and species undetermined

(Fig. 17C)

Material- 42486-555, right P_4; 42486-556, left P_4; 42486-557, right P_4; 42486-558, right P_4; 42486-559, right P^4; 42486-39, left M^3.

Discussion- MacDonald (1955) reviewed the Leptochoeridae, erected the genus Nanochoerus, also recognized Leptochoerus and Stibarus as valid genera, and noted that the group was only known from Oligocene deposits. Van Valen (1971) placed the leptochoerids in the family Dichobunidae, subfamily Leptochoerinae. Edwards (1976) retained Van Valen's subfamily classification, recognized only a large genus, Leptochoerus, and a small genus, Stibarus, and referred specimens assigned to Nanochoerus by MacDonald (1955) to those two genera. Black (1978:233) returned the group to family rank and reported the first discovery of an Eocene leptochoerid, an indeterminate M_2 from the late Eocene Wood locality of the Badwater Creek, Wyoming fauna. Storer (1984:78) also gave the leptochoerids familial rank, and as Edwards (1976) did, recognized only Leptochoerus and Stibarus from the Oligocene, but described a new genus and species, Ibarus ignotus, which he based on specimens from the Uinta C correlate, the Swift

Current Creek local fauna of Saskatchewan.

Four lower fourth premolars (42486-555, -556, -557, and -558) display the morphology typical of the fourth premolars of some members of the Leptochoeridae. Edwards (1976:104) described the cusp morphology of the P_4 of Leptochoerus elegans as "P_4 has a single principal cusp, with a small anterior accessory cusp positioned medially, and two small posterior accessory cusps positioned labially and lingually." That is an accurate description of the morphology of the Casa Blanca leptochoerid P_4's whose cusp positions were determined by composite analysis because the teeth display varying amounts of completeness and wear. Although 42486-555 is complete, the central primary cusp is worn to the level of, and obscures, the posterior accessory cusps. Tooth 42486-558 shows little wear, but the anterior cusp and posterior edge are missing because of post-mortem breakage. Teeth 42486-556 and 42486-557 display an intermediate amount of in-life wear, but are missing the anterior cusp because of breakage.

Measurements of the P_4's of Oligocene leptochoerid specimens were given by MacDonald (1955). Specimens assigned to Stibarus by Edwards (1976) have much smaller P_4's than the Casa Blanca specimens. The Casa Blanca teeth are only slightly larger than the P_4's of some individuals referred by Edwards to Leptochoerus elegans. The P_4's of SDSM 3375 and UNSM 5469 are 7.8 and 7.4 mm long, and

5.0 and 5.4 mm wide, respectively (MacDonald, 1955:458). The only complete leptochoerid P_4 from the Casa Blanca fauna (42486-555) is 8.7 mm long and 5.5 mm wide. Leptochoerus emilyae and L. supremus are larger than L. elegans and may have had P_4's in the size range of the Casa Blanca specimens, but that tooth is not present in the type specimens of the first two species.

Only the anterior half of the P_4 of Ibarus ignotus is known. The tooth fragment has a cusp morphology typical of the P_4 of several leptochoerids and has a transverse length of 3.5 mm (Storer, 1984:81). The range in transverse length of the Casa Blanca leptochoerid P_4's is 5.5-7.3 mm and probably indicates that they belonged to a species larger than I. ignotus. The M_2 from the Badwater Creek area described by Black (1978) cannot be directly compared with the Casa Blanca specimens, but seems to represent a smaller species than the Casa Blanca leptochoerid.

A right P^4 (42486-559) is heavily worn but resembles the P^4 in specimens referred to Leptochoerus elegans by Edwards (1976:104). These teeth are bi-cusped with a rounded labial cusp and a partially selenodont lingual cusp whose posterior portion of the selene is roughly three times longer than the anterior portion. The P^4 in a specimen (SDSM 3375) referred to L. elegans by Edwards (1976:104) is 5.5 mm long and 7.6 mm wide. The same dimensions in 42486-559 are 5.7 and 7.9 mm.

An M^3 (42486-39) displays the bunodont morphology typical of members of the Leptochoeridae and Dichobunidae. The two families may be differentiated by the presence of relatively small posterior molars in the Leptochoeridae (Macdonald, 1955:439). Macdonald (1955:459) noted that upper molars of Leptochoerus are similar to those of Diacodexis. The length and width of 42486-39 are 3.7 and 4.8 mm. The measurements of the M^3's of two specimens referred to L. elegans by Edwards (1976:104), SDSM 3375 and UNSM 5469, are 3.8 and 3.8 mm long, and 5.2 and 5.3 mm wide, respectively. The similarity of the size of the Casa Blanca $P^4/_4$'s to those of these two specimens was discussed above. It is likely that the $P^4/_4$'s and M^3 belong to members of the same family, as no other bunodont artiodactyl teeth are known from the Casa Blanca fauna. The size of the M^3 is consistent with that of species of Leptochoerus having P4/4's in the Casa Blanca size range. The M^3 is tentatively referred to an undermined member of the Leptochoeridae. This tooth was prematurely used as the basis for listing the genus Diacodexis in the Casa Blanca fauna (Westgate, 1987:29A). The presence of a small basin where the metaconule is located on the upper molars of Diacodexis precludes the assignment of 42486-39 to that genus.

The Casa Blanca leptochoerid specimens are closer in size and morphology to specimens of Leptochoerus than to other members of the family. The earliest reported record of Leptochoerus is from the Chadronian age Pipestone's Spring local fauna (Storer, 1984:79). The

Casa Blanca specimens are too fragmentary to permit generic assignment. They are significant in being the third occurrence of leptochoerid remains in an Eocene fauna and in indicating that a leptochoerid at least superficially resembling Leptochoerus had evolved by middle Eocene time.

Family Agriochoeridae Leidy, 1869

Genus Protoreodon Scott and Osborn, 1887

Gazin (1955) reviewed the Agriochoeridae and noted that along with other characters, Protoreodon may be distinguished from Agriochoerus by the retention of a protoconule on the upper molars of the former. The third agriochoerid genus, Diplobunops, is primarily distinguished from Protoreodon by rostral morphology and anterior dentition (Gazin, 1955:61; Westgate and Emry, 1985:244). However, no species of Diplobunops as small as P. petersoni or P. parvus have been described. Therefore, although Diplobunops and Protoreodon display similar molar cusp morphology, relatively small molar size is characteristic of some species of Protoreodon, but not of Diplobunops.

Protoreodon petersoni Gazin, 1955

(Fig. 17D)

Material- 42486-222, right M^1; 42486-572, right M^1; 42486-501,

left $M^{2(?)}$; 42486-139, lingual 1/2 of left molar; 42486-251, left molar fragment; 42486-177, left P_4; 42486-107, posterior 3/4 of left $M_{1 \text{ or } 2}$; 42486-77, lower molar fragment.

Discussion- Gazin recognized six species of Protoreodon in 1955: P. pumillus, P. parvus, P. paradoxicus, P. minor, P. primus, and P. petersoni. He described a seventh species, P. pearcei, the following year (Gazin, 1956:27). Wilson (1971:8) statistically analyzed the variation in specimens of Protoreodon and concluded that P. primus is a synonym of P. pumilus, retained the other six species recognized by Gazin (1955, 1956), and reassigned "Agriochoerus" minimus to P. minimus. Golz (1976) added two more species to the genus by describing a new species, P. pacificus, and referring "Agriochoerus" transmontanus to P. transmontanus. Black (1978:237) considered P. pearcei a junior synonym of Diplobunops matthewi, thus leaving eight species in the genus Protoreodon.

Two small M^1's from the Casa Blanca Quarry closely resemble those of specimens from the Candelaria local fauna of Trans-Pecos Texas which Wilson (1971:23) referred to P. petersoni. The Casa Blanca molars (42486-222 and -572) are 6.7 and 6.4 mm long, and 8.7 and 7.2 mm wide. The M^1 of the type specimen of P. petersoni is 6.5 mm long and 7.9 mm wide (Gazin, 1955:60). The M^1's of other species of Protoreodon are significantly larger.

A left molar (42486-501) appears to be an M^2 as its protocone extends only slightly more lingually than the metaconule. The

protocone on the M^1 of specimens of P. petersoni from Trans-Pecos Texas extends distinctively more lingually than the metaconule. The Casa Blanca $M^{2(?)}$ is 7.6 mm long and 9.1 mm wide. This compares well with the M^2 of the type specimen of P. petersoni which is 7.9 mm long and 9.8 mm wide (Gazin, 1955:60).

Two upper molar fragments (42486-139 and -251), similar in size to 42486-501, display protoconules, and are referred to P. petersoni. A P_4 (42486-177) and two fragmentary lower molars (42486-77 and -107) are also referred to P. petersoni. The P_4 is 6.2+ mm long and 3.5 mm wide. The P_4 from the type of P. petersoni is 6.5 mm long and 4.6 mm wide (Gazin, 1955:60).

Protoreodon petersoni was first reported from the Uinta C Myton Pocket in the Uinta Basin (Gazin, 1955:59). Gazin (1956:26) reported Protoreodon cf. P. petersoni in the Badwater fauna of the Wind River Basin, Wyoming. Black (1978:235) concurred with this taxonomic assignment. Gazin (1956:5) correlated the Badwater fauna with the upper Uintan stage, close to that of Myton pocket.

Ferrusquia-Villafranca (1969:116, 1984:190) found P. petersoni in the early Chadronian Rancho Gaitan local fauna of northeastern Chihuahua, Mexico. Wilson (1971:23) reported P. petersoni in the Uinta C correlate, the Candelaria local fauna, which was collected from the Colmena Tuff Formation of the Vieja area of Trans-Pecos Texas. Recently, Wilson (1986:373) reported P. petersoni in the Serendipity, and Skyline and Cotter channels local faunas from the Agua

Frio-Green Valley area of Trans-Pecos Texas. The Serendipity local fauna comes from the middle member of the Devil's Graveyard Formation and is late Uintan in age (Wilson, 1986:356). The Skyline and Cotter channels local fauna comes from the Bandera Mesa Member of the Devil's Graveyard Formation and is early Duchesnean in age (Wilson, 1986:359).

Family Protoceratidae Marsh, 1891

Genus Leptoreodon Wortman, 1898

Gazin (1955:86) reviewed the species of Leptoreodon and recognized L. marshi and L. edwardsi. He noted that the former is a little larger than the latter and that there are morphologic differences in the premolars of the two species. Golz (1976) added three new species to the genus, which in order of increasing size are L. pusillus, L. leptolophus and L. major. Black (1978:247) recognized the genus Leptoreodon, but predicted that a thorough review of the specimens assigned to Leptoreodon and Leptotragulus would probably indicate that the former is really a junior synonym of the latter. Generic distinction will be retained here, although I recognize that Black's prediction may be correct.

Leptoreodon pusillus Golz, 1976

(Figs. 17 E; 18A)

Material- 42486-224, right M^1; 42486-352, upper molar fragment; 42486-216, lower molar fragment.

Discussion- A small species of Leptoreodon is represented by an M^1 (42486-224). Golz (1976:62) described the smallest known species of Leptoreodon, L. pusillus, based on specimens from Laguna Riviera quarry, San Diego County, California. Other than size, L. pusillus differs from other species of Leptoreodon primarily in premolar morphology. The Laguna Riviera population of L. pusillus has an M^1 length range from 5.4-5.6 mm [n=2] (Golz, 1976:64). The Casa Blanca M^1 is 5.1 mm long and 6.1 mm wide. The combined range in length of the Laguna Riviera M^1's and the Casa Blanca molar has a coefficient of variation of 4.7, which is well within the range of variation for most living species of mammals. Two small Leptoreodon teeth, an upper molar fragment (42486-352) and a lower molar fragment (42486-216), are also referred to L. pusillus.

The Laguna Riviera local fauna was collected from the Santiago Formation which is locally composed of lagoonal, fluviatile and nearshore deposits. Golz (1976:5) and Golz and Lillegraven (1977:48) correlated the land mammal fauna with the Uinta C faunas. Golz and Lillegraven (1977:48) noted that middle Eocene molluscs are known from Santiago Formation deposits in the Santa Ana Mountains, but stated that the Santiago Formation probably contains upper Eocene

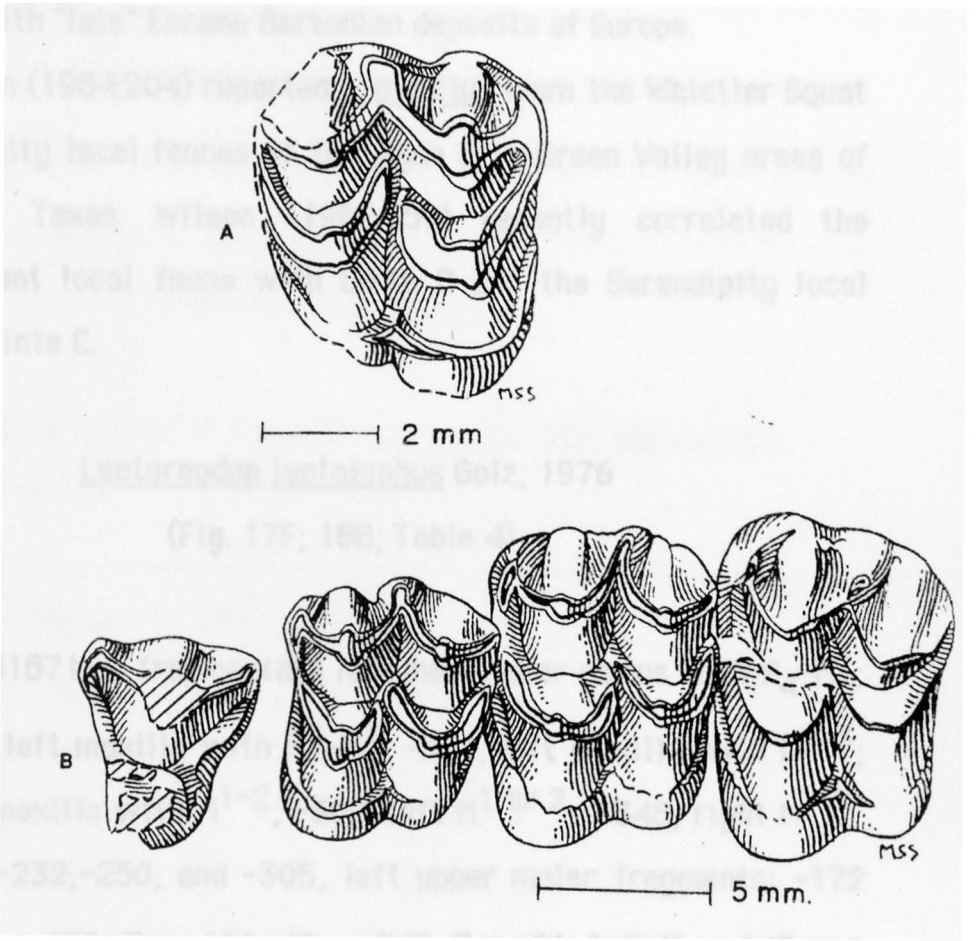


FIGURE 18. **A.** Leptoreodon pusillus right M^1, occlusal view, 42486-224. **B.** Leptoreodon leptolophus left maxilla with P^4-M^3, occlusal view, 42486-571.

strata as well. Golz and Lillegraven (1977:49) and Lillegraven (1979:334) correlated the Laguna Riviera portion of the Santiago Formation with "late" Eocene Bartonian deposits of Europe.

Wilson (1984:204) reported L. pusillus from the Whistler Squat and Serendipity local faunas of the Agua Fria-Green Valley areas of Trans-Pecos Texas. Wilson (1986:359) recently correlated the Whistler Squat local fauna with Uinta B and the Serendipity local fauna with Uinta C.

Leptoreodon leptolophus Golz, 1976

(Fig. 17F; 18B; Table 4)

Material- 41871-1, fragmentary left mandibular ramus with P_4-M_3; 42486-571, left maxilla with P^4-M^3; -321, left maxilla with M^{2-3}; -347, right maxilla with M^{1-2}; -309, left $M^{1\text{ or }2}$; -348, right $M^{1\text{ or }2}$; -2, -88, -232,-250, and -305, left upper molar fragments; -172 and -173, P_2; -150, P_3; -106, dP_4; -349, P_4; -21, left M_1; -242 and -342, right M_1; -361, right M_2; -60 and -240, left M_3; -86 and -191, fragmentary lower molars.

Discussion- Wilson (1984:205) described a mandibular fragment (41871-1) with P_4-M_3 which he referred to L. leptolophus. The specimen was collected 4.7 m below the surface during excavation of sandstone in the Lake Casa Blanca spillway. Wilson (1984:205) compared Texas specimens of L. leptolophus, L. marshi and L. edwardsi

and noted that the P_4 metaconid is poorly developed and the posterior lobe of the M_3 is more closed in the former species, while the P_4 metaconid is well developed and the posterior lobe of the M_3 is not as closed in the latter two species. Wilson (1984:205) also found the P_4 of Texas specimens of L. leptolophus to be less elongate than that of L. marshi, and more so than that of L. edwardsi.

Table 4A. Measurements of Casa Blanca Leptoreodon leptolophus P^3-M^3.

Specimen #	Meas.	dP^3	P^4	M^1	M^2	M^3	M^{1-3}
42486-571	L		4.5	5.4	6.4	6.5	19.5
	W		5.8	7.4	9.5	10.0	
-321	L				6.6	6.5	
	W				9.3	9.7	
-347	L			5.6	6.7		
	W			8.1	10.0		
-500	L	7.3					
	W	4.5					

Three partial maxillae and 23 isolated teeth collected from the Casa Blanca quarry are also referred to L. leptolophus. The upper molars display minor variations in their lingual cingulae in

comparison with those described by Golz (1976), but otherwise add no new information to his detailed description.

Table 4B. Measurements of Casa Blanca Leptoreodon leptolophus P_4-M_3.

Specimen #	Meas.	P_4	M_1	M_2	M_3
41871-1	L	5.8	6.2	6.7	11.3
	W	3.5	4.9	5.5	6.1
42486-60	L				9.7
	W				5.5
-240	L				10.6
	W				5.9
-241	L				--
	W				5.7
-21	L		6.0		
	W		4.9		
-242	L		5.8		
	W		4.7		
-342	L		6.1		
	W		4.9		

Leptoreodon leptolophus was first reported from a Uinta C

equivalent, the Laguna Riviera local fauna of San Diego County, California (Golz, 1976). Wilson (1984:205) reported L. leptolophus from the Candelaria local fauna of the Vieja area of Trans-Pecos Texas, in addition to the Casa Blanca occurrence. The Trans-Pecos specimens come from the Colmena Tuff which is a Uinta C correlate (Wilson, 1986:359).

Genus Toromeryx Wilson, 1974

Toromeryx cf. T. marginensis Wilson, 1974
(Figs. 17G, H; 19)

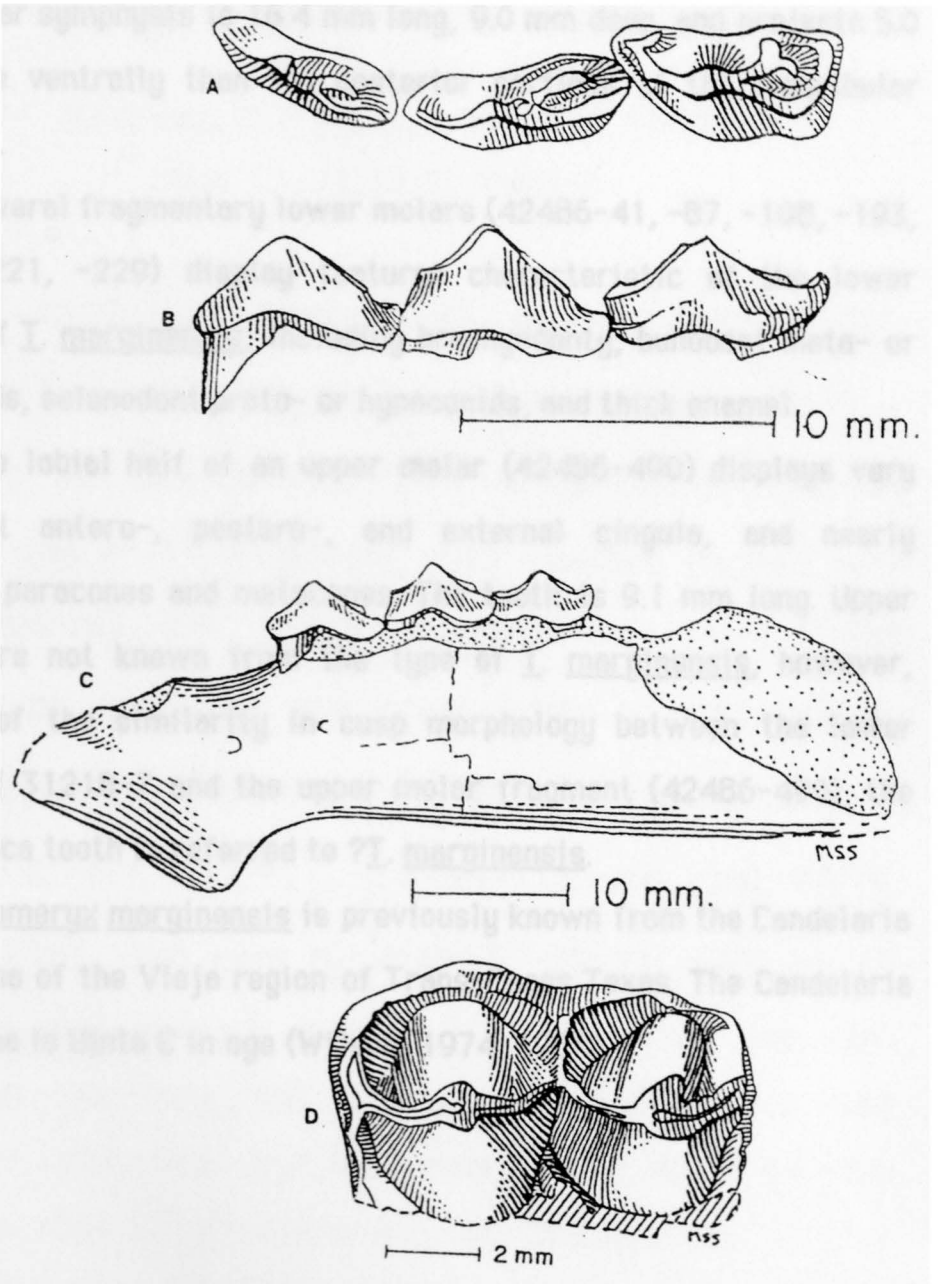
Material- 42486-164, left mandible with symphyseal region, P_1 alveolus and P_{2-4}; 42486-41, -87, -108, -193, -202, and -299, fragmentary lower molars; 42486-221, posterior half of left M_3; 42486-490, labial half of upper molar.

Discussion- Wilson (1974:7) based Toromeryx marginensis on a mandible with a fragmentary right P_3, right P_4-M_3 and left M_{2-3}. T. marginensis is a medium-sized protoceratid characterized by prominent external cingula, almost bunodont ento- and metaconids, selenodont proto- and hypoconids, recurved internal stylids forming almost closed or closed pockets, a metaconid ridge on P_4, and low, bulbous teeth with thick enamel (Wilson, 1974:7).

The anterior portion of a left mandible, 42486-164, possesses P_{2-4}. Only the talonid of the P_3, and the P_4, may be directly compared with the type specimen of T. marginensis, 31218-7. The talonid of the P_3 of 42486-164 resembles that of 31218-7 in possessing a prominent external crest extending to the postero-external corner of the tooth, an internal crest originating as a metaconid ridge, an internal cingulum, and a posteriorly open basin. The P_4 in 42486-164 compares closely with that in 31218-7 and possesses a prominent cingulum extending from the small paraconid to the metaconid, a metaconid crest extending to the postero-internal corner of the tooth, and a talonid basin on the lingual half of the tooth. The P_4 of 42486-164 is smaller than that of the type specimen. The former is 7.4 mm long and 3.4 mm wide, while the latter is 8.6 mm long and 4.8 mm wide. The mandibular rami of 31218-7 are also more robust than the mandibular ramus of 42486-164. The significance of the size differences is not clear, as the statistical population of these characters is represented by only two individuals.

The Casa Blanca mandibular fragment displays characters not present in the type specimen of T. marginensis. The caniniform P_1 alveolus is 4.6 mm long and 2.7 mm wide. The P_2 is 6.2 mm long and 2.3 mm wide. The P_2 generally resembles the P_3, but the metaconid ridge originates on the external crest just posterior to the protoconid, on the former, rather than originating at the protoconid,

FIGURE 19. Toromeryx cf. T. marginensis. **A-C.** Left mandible with P_1 alveolus and P_{2-4}, 42486-164. **A.** Occlusal view of P_{2-4}. **B.** Labial view of P_{2-4}. **C.** Left lateral view of mandible. **D.** Partial upper molar, occlusal view, 42486-490.



and the P_2 talonid is narrower than the P_3 talonid. The tooth row from P_{1-4} is 32.5 mm long and from P_{2-4}, 20.2 mm long. The robust mandibular symphysis is 16.4 mm long, 9.0 mm deep, and projects 5.0 mm more ventrally than the posterior portions of the mandibular fragment.

Several fragmentary lower molars (42486-41, -87, -108, -193, -202, -221, -229) display features characteristic of the lower molars of T. marginensis, including brachyodonty, bunodont meta- or entoconids, selenodont proto- or hypoconids, and thick enamel.

The labial half of an upper molar (42486-490) displays very prominent antero-, postero-, and external cingula, and nearly bunodont paracones and metacones. The tooth is 9.1 mm long. Upper molars are not known from the type of T. marginensis, however, because of the similarity in cusp morphology between the lower molars of 31218-7 and the upper molar fragment (42486-490), the Casa Blanca tooth is referred to ?T. marginensis.

Toromeryx marginensis is previously known from the Candelaria local fauna of the Vieja region of Trans-Pecos Texas. The Candelaria local fauna is Uinta C in age (Wilson, 1974; 1986).

Order Rodentia

Family Ischyromyidae

Genus Mytonomys Wood, 1956

Mytonomys cf. M. robustus (Peterson, 1919)

(Figs. 17 I-M; 20; 21; Table 5)

Material- 42486-1, left mandible with I and M_{2-3}; 42486-31, right mandibular fragment with M_2; 42486-277, left mandible with M_{1-3}; 42486-278, left mandible with P_4-M_3; 42486-228, left maxillary fragment with P^4-M^1; 42486-573, right maxillary fragment with M^{1-3}; 42486-163, -239, -564, left P_4; 42486-55, -114, -178, right P_4; 42486-22, -279, -319, -655, left M_1; 42486-65, -301, right M_1; 42486-320, left M_2; 42486-56, -109, -188, -351, right M_2; 42486-4, -6, -43, -79, -111, -565, $M_{1 \text{ or } 2}$; 42486-112, -205, -560, left M_3; 42486-3, -147, -340, right M_3; 42486-8, -35, 71, -187, left P^4; 42486-17, -184, right P^4; 42486-11, -12, -33, -128, -142, -281, -341, -350, -353, -562, -566, -656, left $M^{1 \text{ or } 2}$; 42486-113, -137, -185, -227, -229, -302, -357, -657, right $M^{1 \text{ or } 2}$; 42486-64, -190, -194, -230, -561, left M^3; 42486-246, and -372, right M^3.

Discussion- Wood (1956) erected the genus Mytonomys and placed two formerly described species, Prosciurus? robustus (Peterson, 1919) and Leptotomus burkei (Wilson, 1940) in it. Black (1968) gave

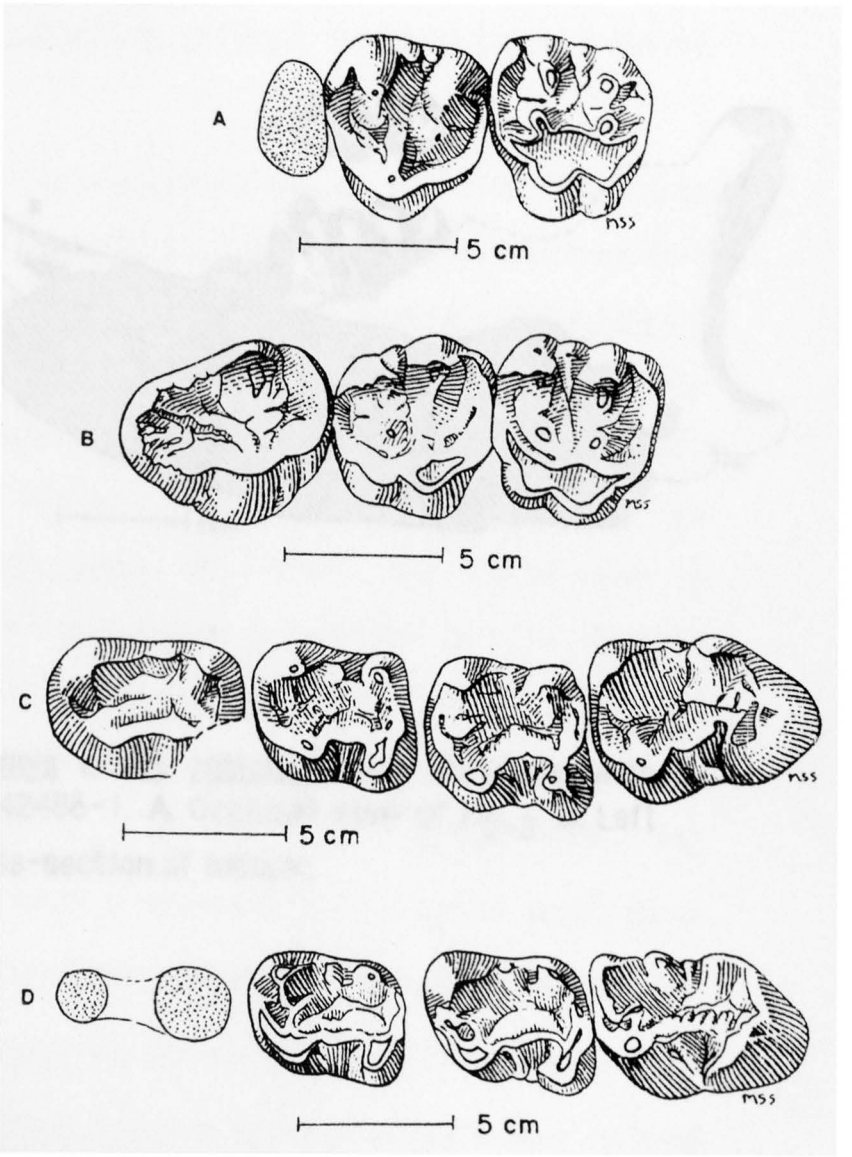


FIGURE 20. Mytonomys cf. M. robustus. **A.** Left P^3 alveolus and occlusal view of P^4-M^1, 42486-228 . **B.** Occlusal view of right M^{1-3}, 42486-573 . **C.** Occlusal view of left P_4-M_3 in mandible 42486-278 . **D.** Occlusal view of left P_4 alveolus and M_{1-3} in mandible 42486-277

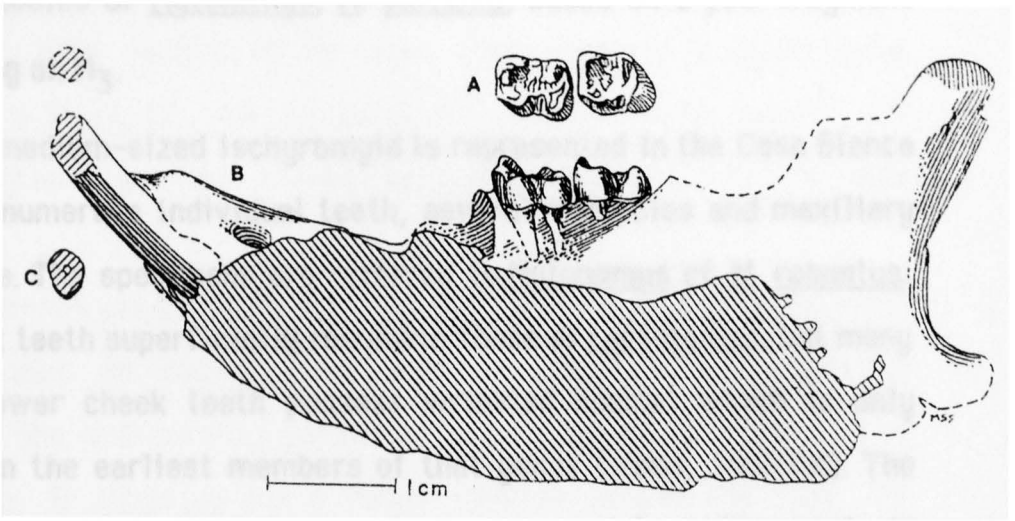


FIGURE 21. Mytonomys cf. M. robustus, left mandible with incisor, and M_{2-3}, 42486-1. **A**. Occlusal view of M_{2-3}. **B**. Left lateral view. **C**. Cross-section of incisor.

the first description of the M. robustus upper dentition and revised the species diagnosis. Ferrusquia-Villafranca and Wood (1969) named a third species of Mytonomys, M. gaitania, based on a jaw fragment possessing an M_3.

A medium-sized ischyromyid is represented in the Casa Blanca fauna by numerous individual teeth, several mandibles and maxillary fragments. The specimens are referred to Mytonomys cf. M. robustus. The cheek teeth superficially resemble those of Leptotomus, but many of the lower cheek teeth possess wrinkled enamel which is only present in the earliest members of that genus (Wood, 1962:64). The lower incisor of Leptotomus is narrow and compressed in cross-section, while the lower incisor in mandible 42486-1 displays a semi-circular cross-section with a flat medial surface.

The Casa Blanca Mytonomys differs from M. burkei in possessing a distinctively wider and larger M_3. The M_3 of M. burkei ranges from 4.45-4.54 mm in width [n=3] and from 6.31-6.44 mm in length [n=3] (Wood, 1962:229). The Casa Blanca Mytonomys M_3's range from 4.6-5.2 mm in width [n=7] and from 6.4-7.3 mm in length [n=9]. The M_3 of M. robustus ranges from 4.72-5.13 mm in width [n=7] and from 6.45-6.80 mm in length [n=8] (Wood, 1962:228). The even larger M_3 of M. gaitania is about 5.7 mm wide and 7.55 mm long (Wood, 1974:6).

The Casa Blanca Mytonomys teeth overlap and exceed the range in size of teeth previously referred to M. robustus. Lengths of the lower

cheek teeth of M. robustus, excluding the M_3, are: P_4, 5.10-5.87 [n=2]; M_1, 4.71-5.32 [n=4]; and M_2, 6.45-6.80 [n=6] (Wood, 1962:228). Black (1968:855) gave lengths of the upper cheek teeth of M. robustus as: P^4, 4.8-4.9 [n=4]; M^1, 4.8-5.0 [n=4]; M^2, 4.9-5.0 [n=4]; and M^3, 5.5 [n=1]. Lengths of the Casa Blanca Mytonomys teeth are listed in Table 5.

It cannot yet be determined if the Casa Blanca Mytonomys teeth indicate that an Eocene population of large-sized M. robustus inhabited the present-day Laredo area or whether two species of Mytonomys, M. robustus and a larger species, shared the area. The coefficients of variation for the teeth have acceptable values for inclusion in one species. Scatter diagrams of tooth sizes show a tendency for some of the teeth to plot in two clusters, however the samples are too small to allow understanding the significance of this. Most of the largest Mytonomys teeth are retained in the relatively more complete specimens of jaws and maxillary fragments having multiple teeth (42486-1, -228, -278, and -573), while the smaller teeth tend to be isolated specimens. Taphonomic processess causing excessive fragmentation include increased time and distance of transport, and biofragmentation caused by carnivores and scavengers. The relatively good preservation of the larger specimens may be the result of those individuals having lived closer to the depositional site, indicating a more proximal habitat existed for a larger species. Alternatively, fragmentation of the smaller individuals may indicate

a lesser resistance to the mechanical forces incurred during transport, or a higher predation susceptibility of smaller individuals within one highly variable species. A larger population sample, especially one with jaws or maxillae bearing the smaller Mytonomys teeth, should resolve this taxonomic dilemma.

Table 5. Measurements (mm) of the teeth of Mytonomys cf. M. robustus from the Casa Blanca quarry.

Tooth	OR-L	CV	N	OR-W	CV	N
P_4	5.3-6.3	6.634	5	4.0-4.2	2.051	5
M_1	5.0-5.8	5.001	8	4.2-4.7	3.798	8
M_2	5.1-6.2	6.208	9	4.0-5.4	7.471	9
M_3	6.4-7.3	4.060	9	4.6-5.2	4.059	7
P^4	4.7-5.6	6.795	7	5.0-6.1	6.531	7
M^1	5.5-5.6	1.274	2	5.9-6.0	1.188	2
M^2	5.7	–	1	5.6	–	1
$M^{1 \text{ or } 2}$	4.8-5.5	3.928	19	5.0-5.7	6.531	19
M^3	5.7-6.4	4.732	8	4.5-5.3	5.014	8

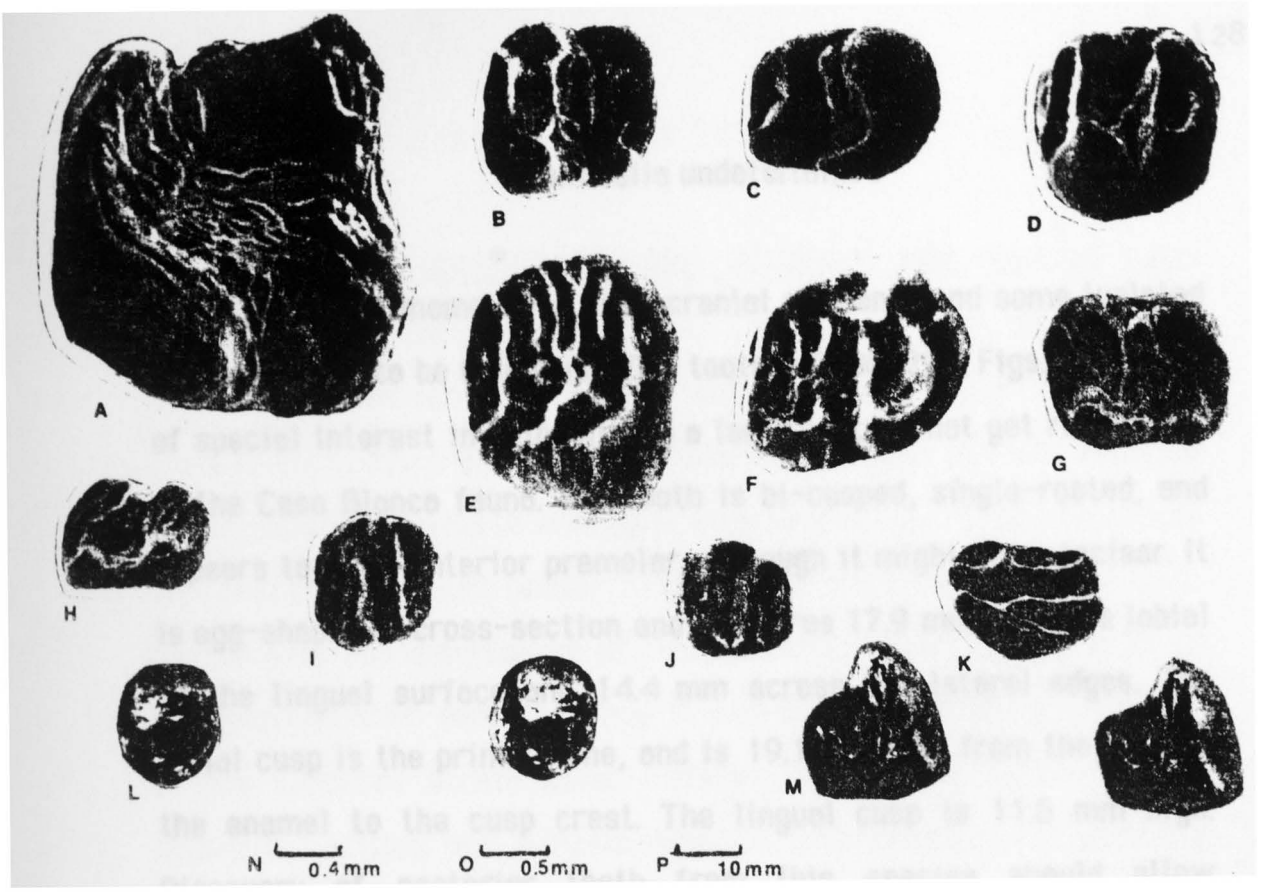
CV= coefficient of variation, N= sample size, OR-L= range of antero-posterior length, OR-W= range of greatest width.

Mytonomys robustus is previously known from the Uinta C, Myton Pocket of northeastern Utah. This species was also reported to occur in the Swift Current Creek local fauna (Russell, 1965:10), but Storer (1984:93) recently referred that material to Pseudotomus cf. P. eugenei.

Rodentia under study

Over 200 teeth of eight additional rodent species have been recovered from the Casa Blanca quarry and are still under study. These species include four ischyromyids; Thisbemys sp. (Fig. 22A), Microparamys sp. (Fig. 22B), an unidentified species intermediate in size between the Thisbemys sp. and the Mytonomys cf. M. robustus, and a species distinctly larger than Mytonomys cf. M. robustus. Several upper and lower teeth from a new genus and species of cylindrodontid have been recovered (Figs. 22E, F). The other three taxa are previously undescribed micro-rodent species. One is a new species of sciuravid in the genus Pauromys (Figs. C, D). Another is a new genus and species questionably in the family Eutypomyidae (Figs. 22G, H). The third species is a new genus and species of lophate-toothed rodent with teeth superficially resembling those of the early glirids, but whose family affiliation has not been determined (J. A. Wilson and J. W. Westgate, in prep.; Figs. 22 I-K).

FIGURE 22. Rodent and unidentified mammal teeth from the Casa Blanca quarry. A-K are SEM photograpghs. **A.** Thisbemys sp. $M^{1 \text{ or } 2}$, occlusal view displaying etching possibly the result of digestive tract acids, 42486-69; **B.** Microparamys sp. $M_{1 \text{ or } 2}$, occlusal view, 42486-386; **C.** Pauromys sp. M_3, occlusal view, 42486-408; **D.** Pauromys sp. $M^{1 \text{ or } 2}$, occlusal view, 42486-515; **E.** cylindrodontid, n. gen. and sp., upper molar, occlusal view, 42486-238; **F.** cylindrodontid, n. gen. and sp., lower molar, occlusal view, 42486-214; **G.** ?eutypomyid, n. gen. and sp., $M_{1 \text{ or } 2}$, 42486-480; **H.** ?eutypomyid, n. gen. and sp., $M_{1 \text{ or } 2}$, occlusal view, 42486-544; **I.** rodent, n. ?fam., gen. and sp., ?lower molar, occlusal view, 42486-387; **J.** rodent, n. ?fam., gen. and sp., P_4, occlusal view, 42486-487; **K.** rodent, n. ?fam., gen. and sp., P_4 or dP_4, antero-occlusal view showing lophate ridges and brachyodont crown, 42486-488; **L.** unknown mammal ?premolar, occlusal stereophoto view, 42486-293; **M.** unknown mammal ?premolar, posterior stereophoto view, 42486-293. **N.** Scale for B-D, and G-K. **O.** Scale for A, E and F. **P.** Scale for L and M.


A
B
C
D
E
F
G
H
I
J
K
L
M
N 0.4mm
O 0.5mm
P 10mm

Mammalia undetermined

Numerous mammalian post-cranial elements and some isolated teeth have yet to be identified. One tooth (42486-293, Figs. 22L, M) is of special interest in belonging to a large species not yet recognized in the Casa Blanca fauna. The tooth is bi-cusped, single-rooted, and appears to be an anterior premolar, although it might be an incisor. It is egg-shaped in cross-section and measures 17.9 mm from the labial to the lingual surface and 14.4 mm across the lateral edges. The labial cusp is the primary one, and is 19.1 mm high from the base of the enamel to the cusp crest. The lingual cusp is 11.6 mm high. Discovery of posterior teeth from this species should allow identification of the taxon if it has been discovered elsewhere.

STRATIGRAPHIC CORRELATION

UINTAN NORTH AMERICAN LAND MAMMAL AGE. Charles Lyell (1833:55) based the Eocene Epoch on London and Paris Basin strata possessing a marine invertebrate fauna containing only 3.5% extant species. Early biostratigraphic correlation between the land mammal bearing beds of the North American interior and Lyell's type localities was imprecise because of the rarity of land mammals in the European marine beds and the absence of Eocene marine invertebrates in North American interior deposits. Thus it was difficult to apply the terms of the European strata-based Tertiary time scale to non-marine strata of Tertiary age in North America. This problem was partially solved by Wood and others (1941) with the establishment of the North American Provincial Age time scale based on Tertiary land mammals and independent from the Lyellian time scale. Wood and others (1941) erected four North American Provincial Ages which they correlated with European Eocene strata. These ages, from oldest to youngest, are the Wasatchian, Bridgerian, Uintan and Duchesnean. The following account is a review of papers reflecting the general consensus of the correlation of the Uintan North American Land Mammal Age by Paleogene researchers.

Wood and others (1941: pl. 1) considered the Uintan Provincial Age deposits to be correlative of upper Eocene Bartonian strata of Europe. Gazin and Sullivan (1942:4) correlated the middle Eocene Cook Mountain Formation of Mississippi [Lisbon Formation at that time

(Grim, 1936; Thomas, 1942)] with the lowermost Bartonian Stage of Europe, and based on the occurrence of the titanothere Notiotitanops mississippiensis, suggested that the Uintan Stage was no younger than the lowermost Bartonian deposits and might be as old as the Lutetian deposits.

Savage (1962:54) formally renamed the provincial ages of the Wood committee to be the North American Land Mammal "Ages." Savage (1962:57) placed the Uintan NALMA in the late Eocene, with the Duchesnean straddling the Eocene/Oligocene boundary, and added the late Clarkforkian to the earliest Eocene. Black and Dawson (1966) reviewed the late Eocene mammalian faunas of North America and considered the Uintan faunas to be late Eocene in age. Black and Dawson (1966:325, 330, 346) also considered the type specimen of Notiotitanops mississippiensis to have come from a fluvial deposit of late Eocene age, although it was found in association with middle Eocene marine invertebrates (see the discussion on Previous Work-Gulf Coastal Plain Eocene land mammals).

Golz and Lillegraven (Golz, 1976; Golz and Lillegraven, 1977; Lillegraven, 1979) studied Uintan faunas from non-marine and marginal marine deposits in the San Diego, California area. Golz (1976:16) correlated Uinta A, B, and C faunas with the Domengine, Transition and Tejon California molluscan ages, respectively. Golz (1976:16) further correlated Uinta A and B with upper Lutetian deposits of Europe which he considered to be of middle Eocene age. He (Golz, 1976:16) correlated Uinta C with Bartonian deposits of Europe

which he considered early late Eocene in age. Golz and Lillegraven (1977:49) revised the correlations of Golz (1976), and showed slightly younger correlations between the southern California mammal- bearing beds and the California marine molluscan "stages." The part of the Friars Formation bearing early Uintan mammals (Uinta A?) was correlated with the "Transition Stage", while the portion of the Mission Valley Formation bearing slightly younger mammals (Uinta B?) was correlated with the earliest "Tejon Stage" (Golz and Lillegraven, 1977:49). The Sespe Formation with Uinta C mammals was correlated with a younger part of the "Tejon Stage" (Golz and Lillegraven, 1977:49). This revised correlation places only the earliest Uintan faunas, those collected from the Friars Formation (Uinta A?), in the middle Eocene (Golz and Lillegraven, 1977:46), with the Uinta B? and C faunas in the early late Eocene. Lillegraven (1979:334) more recently presented correlations nearly identical to that of Golz and Lillegraven (1977:49).

Berggren and others (1978) considered the Lutetian and Bartonian beds of Europe to be early middle, and late middle, Eocene, respectively. They (Berggren and others, 1978) correlated the earlier half of the Uintan NALMA with the later half of the Lutetian Stage, and the younger half of the Uintan with the early and middle Bartonian Stage, primarily using K-Ar radiometric evidence from continental rock sequences bearing both volcanics and land mammal remains.

Berggren and others (1985) presented a revised Cenozoic geochronology integrating bio-, litho-, magnetostratigraphic and

radiometric data which has been accepted by the Committee on Geochronology as the Decade of North American Geology's standard Cenozoic time scale. This new time scale dates the Uintan NALMA at 48-42 Ma and correlates it with the later half of the Lutetian Stage and the earlier half of the Bartonian Stage, both of middle Eocene age (Berggren and others, 1985: 1412).

LAREDO FORMATION, CLAIBORNE GROUP: Vertebrate Fauna- The mammalian component of the Casa Blanca vertebrate fauna is more useful in stratigraphic correlations than is the lower vertebrate component. Relatively nearby Eocene volcaniclastic deposits 450 km (280 mi) northwest of Laredo in Trans-Pecos Texas (Fig. 23) provide well studied mammalian faunas for comparison. The current knowledge of the Trans-Pecos faunas was summarized by Wilson (1986).

The regional proximity of the Trans-Pecos Eocene deposits to those of the Rio Grande Embayment allows comparison of faunas which probably lived under broadly similar climatic conditions. There is about 1.5 degrees of latitudinal difference between these two areas today, and the paleolatitudinal difference was probably comparable. Climatic conditions may have been somewhat more moderate at the Laredo site, because of its coastal location, than conditions inland. However, evidence from land snails collected from Uintan deposits in the Agua Fria area indicates that a moist, temperate climate with highly equable conditions existed in that

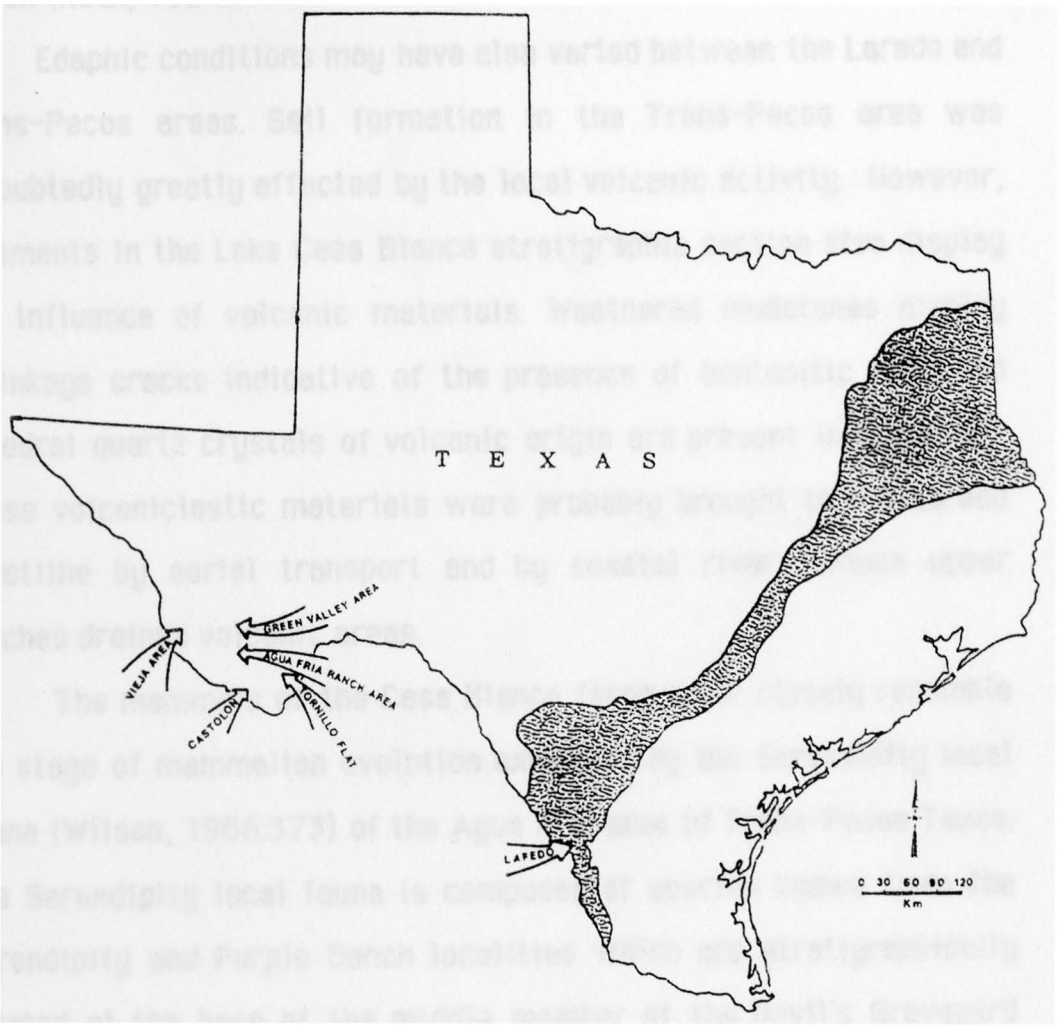


FIGURE 23. Proximity of the Lake Casa Blanca site near Laredo to Uintan fossil localities in Trans-Pecos Texas. The outcrop belt of the middle Eocene Claiborne Group is stippled.

region (Roth, 1984).

Edaphic conditions may have also varied between the Laredo and Trans-Pecos areas. Soil formation in the Trans-Pecos area was undoubtedly greatly affected by the local volcanic activity. However, sediments in the Lake Casa Blanca stratigraphic section also display the influence of volcanic materials. Weathered mudstones display shrinkage cracks indicative of the presence of bentonitic clay, and euhedral quartz crystals of volcanic origin are present in the sands. These volcaniclastic materials were probably brought to the Laredo coastline by aerial transport and by coastal rivers whose upper reaches drained volcanic areas.

The mammals of the Casa Blanca fauna most closely resemble the stage of mammalian evolution exhibited by the Serendipity local fauna (Wilson, 1986:373) of the Agua Fria area of Trans-Pecos Texas. The Serendipity local fauna is composed of species known from the Serendipity and Purple Bench localities which are stratigraphically located at the base of the middle member of the Devil's Graveyard Formation, late Uintan [Uinta C] (Wilson, 1986). A biotite-bearing ash above the stratigraphic horizon yielding the Serendipity local fauna and a biotite-bearing tuff below that horizon have given K-Ar dates of 42.7 Ma and 43.9 Ma, respectively (Stevens, Stevens and Wilson, 1984:13; Wilson, 1986:359). The Serendipity local fauna correlates with the Candelaria local fauna of the nearby Vieja region of Trans-Pecos Texas (Wilson, 1986:356).

Wilson (1986:361) also correlated the Serendipity local fauna

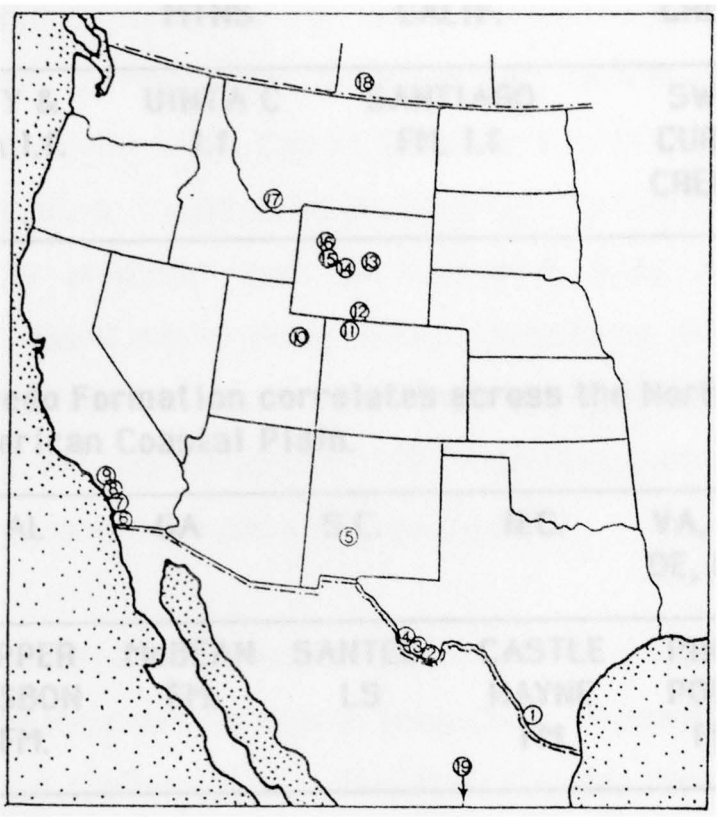


FIGURE 24. Uintan land mammal localities in western North America. **1**, Lake Casa Blanca; **2-4**, Trans-Pecos Texas faunas; **5,10-17**, Rocky Mountain faunas; **6-9**, southern California faunas; **18**, Swift Current Creek, Saskatchewan; **19**, Marfil faunule, Guanojuato, Mexico (questionably of Uintan age).

Table 6. North American Land Mammal local fauna correlates of the Casa Blanca local fauna.

WEST TEXAS	ROCKY MTNS.	SOUTHERN CALIF.	SASKAT-CHEWAN
SERENDIPITY & CANDELARIA l.f.	UINTA C l.f.	SANTIAGO FM. l.f.	SWIFT CURRENT CREEK l.f.

Table 7. Laredo Formation correlates across the North American Coastal Plain.

TX, LA, MS, AR	AL	GA	S.C.	N.C.	VA, MD, DE, N.J.
COOK MTN. FM.	UPPER LISBON FM.	McBEAN FM.	SANTEE LS	CASTLE HAYNE FM.	PINEY POINT FM.

Table 8. Correlation between Uinta C North American land mammals, nannoplankton, and European middle Eocene deposits.

EPOCH	NALMA	NP ZONE	EUROPEAN BEDS
EOCENE (MIDDLE)	UINTAN (C)	16 (UPPER)	UPPER LUTETIAN-LOWER BARTONIAN

NALMA= North American Land Mammal Age, NP= nannoplankton

with classic Uinta C mammal faunas from localities in the intermontane basins of the Rocky Mountains in Utah, Wyoming, Colorado and Montana. Storer (1984:130) recently described the northernmost Uinta C correlate from North America which was collected at Swift Current Creek, Saskatchewan, Canada. Storer (1984:131) considered the Swift Current Creek fauna similar to that known from the Santiago Formation of the San Diego, California area. Wilson (1986:360) predicted that the completed study of the Serendipity local fauna will probably indicate similarity with the mammalian faunas from the upper part of the Santiago Formation which Golz (1976), Golz and Lillegraven (1977) and Lillegraven (1979) described and considered to be Uinta C in age (Table 6).

Lithology and Invertebrate Fauna- Gardner (1938) proposed the name Laredo Formation for Rio Grande Embayment Claiborne Group deposits which had previousy been called Cook Mountain Formation. Gardner (1938:297) noted that the Laredo Formation is distintively sandier than the Cook Mountain Formation of east and central Texas.

Eargle (1968:21) correlated the Sparta Sand from its type locality in Louisiana, across Texas to the Nueces River Valley where the sands merge with the overlying Cook Mountain Formation and together continue across the Rio Grande Embayment as the Laredo Formation. Gardner (1938) did not include the Sparta Sand as a correlate of the Laredo Formation.

Stenzel (1940) was able to correlate a zone in the Landrum

Member of the Cook Mountain Formation of Leon and Houston Counties in east Texas, with a thin zone exposed over 600 km (365 mi) southwest in the middle of the Laredo Formation near Laredo, Texas and at Mier, Tamaulipas, Mexico. Stenzel (1940) based this correlation on occurrences of the gastropod Turritella cortezi which has a stratigraphically restricted vertical distribution, but an extensive lateral one. The Casa Blanca fossil quarry lies approximately 32 m above the T. cortezi zone, near the middle of the Laredo Formation, and may also be correlated with the Landrum Member of the Cook Mountain Formation (Fig. 4).

Stenzel (1940:1671) also correlated the Landrum Member of the Cook Mountain Formation in Leon County, Texas with exposures of the Saline Bayou Member of the formation 290 km (175 mi) to the northeast in Winn Parish, Louisiana. Stenzel's correlations unite a line of outcrops extending over 890 km (540 mi) across most of the western half of the Gulf Coastal Plain. Dockery (1980:22) correlated the Shipps Creek Shale Member of the Cook Mountain Formation in western Mississippi, and the Archusa Marl and Potterchito Members of the formation in eastern Mississippi, with the Landrum Shale Member in east Texas.

Several workers have recently presented marine micro- and macroinvertebrate correlations between the Cook Mountain Formation and more easterly coastal plain formations. Cook Mountain Formation equivalents include the upper Lisbon Formation of Alabama (Zullo, 1984:186; Ward, 1985:49; Siesser and others, 1985:830; Dockery,

1986:584), the McBean Formation of Georgia (Zullo, 1984:186; Ward, 1985:49), the Cubitostrea sellaeformis beds of the Santee Limestone of South Carolina (Zullo, 1984:186), the Castle Hayne Formation of North Carolina (Zullo, 1984; Ward, 1985:49), and the Piney Point Formation of Virginia, Maryland, Delaware and New Jersey (Ward, 1985:3). The preceeding summary indicates Laredo Formation invertebrate fossils are correlated with invertebrate fossils from relatively continuous strata extending along the coastal plain from northeastern Mexico to New Jersey over a distance of roughly 3000 km (1850 mi, Table 7).

The nannoplankton fauna of the Cook Mountain Formation has been placed in the upper half of NP 16 (Dockery, 1986:584). Some workers have recently placed the upper half of NP 16 in the lower half of the Bartonian Stage, late middle Eocene (Berggren et al., 1985:1412; Siesser et al., 1985:828; Martini and Muller, 1986; 100; Hinsch, 1986:3; and Rothhausen, 1986:542). However, Martini (1986:663) and Spiegler (1986:227) put the upper half of NP 16 in the upper part of the Lutetian. Nannoplankton stratigraphers must reach a more refined consensus on the placement of NP 16 within the context of European strata before more precise intercontinental correlations of the Cook Mountain Formation and the portion of the Laredo Formation yielding the Casa Blanca local fauna may be made. Currently, the most refined correlation between the Casa Blanca local fauna deposits and European strata lies within the boundaries of the upper Lutetian and lower Bartonian beds.

Ghosh (1972:101c) reported that sanidine and mica from two bentonite zones in the Cook Mountain Formation, the stratigraphic equivalent of the Laredo Formation northeast of the Rio Grande Embayment, gave four acceptable K-Ar dates of 39.6, 40.8, 41.5 and 42.7 Ma. This is an average of 41.2 Ma. Ghosh (1972:103) reported the average of those four dates as 42 Ma. Adjusted dates using the K-Ar recalibration table of Dalrymple (1979:559) are 40.6, 41.9, 42.6 and 43.8 Ma, with an average age of 42.2 Ma. The bentonites were sampled from exposures of the Hurricane Lentil, Landrum Member, at Alabama Ferry and Hurricane Bayou, Houston County, Texas. Turritella cortezi occurs 0.61 m below the lower bentonite and 4.8 m below the upper bentonite at Alabama Ferry (Stenzel, 1940:1674).

It is significant that the Casa Blanca mammals and invertebrates were independently correlated with faunas found in deposits yielding similar dates from radioactive analyses. The mammals are very similar to Trans-Pecos Texas faunas which may be as young as 42.7 Ma. The east Texas deposits bearing Turritella cortezi appear to be about 42.2 Ma. The descrepancy of 0.5 Ma may indicate that the Casa Blanca local fauna is slightly younger than the Serendipity local fauna of Trans-Pecos Texas. However, the dating discrepancy is less than a 1% difference in age and could also be the result of errors inherent in dating methods. Considering the similarity in calculated ages and the relative proximity of the air-fall volcanic materials in Trans-Pecos and east Texas, these ashes may have had the same source area. The ashes in the Devil's Graveyard Formation are thought to have been

derived from volcanoes in Mexico (Henry and McDowell,1986:113).

Hardenbol and Berggren (1978:226) stated that glauconites from the Barton beds of Great Britain yielded dates of 42.0 and 43.6 Ma according to Odin et al. (1969). These dates are corrected with the Dalrymple formula to 43.1 and 44.7 Ma. Odin (1975) presented revised dates which were several million years younger. These glauconite dates were criticised by Berggren et al. (1978) who suggested that the dates of Odin et al. (1969) were too old, and those of Odin (1975) were too young. If the correlation by Berggren et al. (1978; 1985) between the late Uintan NALMA and the lower Bartonian beds of Great Britain is correct, then the Bartonian corrected glauconite dates of Odin et al. (1969) of 43.1 and 44.7 Ma are close to those of Stevens et al. (1984) and Wilson's (1986) age of the Serendipity (Uinta C) local fauna between 42.7 and 43.9 Ma. Ghosh's (1972) corrected Cook Mountain Formation dates averaging 42.2 Ma are slightly younger than those of Odin et al (1969).

The above correlations indicate that the estimation by Gazin and Sullivan (1942:4) that the Uintan Stage is Lutetian to early Bartonian in age, was accurate. The Casa Blanca local fauna allows further refinement of that correlation by showing that part or all of the Uinta C stage of evolution occurred synchronously with middle Eocene, upper Lutetian to lower Bartonian Stage deposition. The Casa Blanca local fauna is the first Eocene land mammal fauna from the North American Coastal Plain which allows direct and refined biostratigraphic correlations between the terrestrial faunas of the

North American interior and European marine strata (Table 6).

PALEOECOLOGY

The lower vertebrate and invertebrate animals in the Casa Blanca fauna are the best indicators of local paleoecologic conditions yet studied at the site. These ectothermic species are directly influenced by the local climatic conditions and water temperatures. The fishes and invertebrates are greatly influenced by existing conditions in the water chemistry, especially salinity, because of their constant exposure of the gill and other tissues to the water. Mammals and birds tend to be more independent of their climatic surroundings because of their homeothermic physiology. These taxa indirectly reflect climatic conditions because of the relationships between their food sources and the prevailing climate. The pollen obtained from the core drilled at Lake Casa Blanca will provide paleoclimatic evidence independent of that derived from the Casa Blanca fauna.

HABITATS OF LIVING SPECIES. The three species of sharks in the Casa Blanca fauna have modern relatives which are primarily found in warm waters of varying depth. Extant members of the Odontaspidae are found in all tropical to warm temperate seas, but they are associated with continental or insular landmasses, as none of these sharks are oceanic (Compagno, 1987:26). They may be found from the surf zone possibly to depths of 1600 m (Compagno, 1984:214). The

sand shark or gray nurse shark, Eugomphodus taurus, has been reported to attack humans in estuaries and far up rivers, as well as along beaches (Migdalski and Fichter, 1976:51).

The carcharhinid, Carcharhinus, is found in warm temperate seas and is the dominant genus in tropical waters. Species are found from inshore to open ocean waters. One species, the bull shark (C. leucas), is euryhaline and may be found in estuaries, freshwater rivers and lakes, hypersaline lagoons, and coastal waters (Compagno, 1984:479). The river shark, C. zambezensis, lives in the coastal waters and rivers of South Africa (Migdalski and Fichter, 1976:57).

It is not surprising that in the middle Eocene Galeocerdo eaglesomei possessed a trans-Atlantic distribution, as the only living species of tiger shark, G. cuvier, is circumglobal in tropical and warm temperate seas. Modern tiger sharks inhabit a wide range of marine environments and may be found in extremely shallow estuarine waters to the open ocean (Compagno, 1984:504).

The modern relatives of the Casa Blanca batoids also inhabit warm waters, but unlike the sharks, these forms are usually restricted to much shallower depths. Living species of Pristis inhabit warm waters usually less than 11 m deep (Bigelow and Schroeder, 1953:19). They are most common in bays and estuaries, but also ascend coastal rivers above the intertidal range (Bigelow and Schroeder, 1953:19). Pristis microdon, P. cuspidatus, P. pristis and P. leichhardti are commonly found in coastal rivers (Migdalski and Fichter, 1976:69). Thorson, Watson and Cowan (1966) discuss the

occurrence of a population of P. perrotteti in freshwater Lake Nicaragua. Modern species of Rhinobatos are found in tropical and warm-temperate coastal waters and locally may occur in fresh water where they have been observed breeding (Bigelow and Schroeder, 1953:52). Dasyatis generally inhabits shallow waters of tropical to subtropical coastlines (Bigelow and Schroeder, 1953:342). Two species, D. sephen and D. bleekeri are often found in lakes and freshwater streams in Thailand, while another species, D. violacea, is pelagic (Migdalski and Fichter, 1976:76). Modern species of Myliobatis are usually found in estuaries and shallow bays in tropical to warm temperate waters (Bigelow and Schroeder, 1953:436-437). Modern species of Rhinoptera are found in coastal waters of most tropical and warm-temperate latitudes (Bigelow and Schroeder, 1953:466).

Living relatives of the Casa Blanca bony fishes inhabit a wider variety of environments than the chondrichthyans discussed above, however all are found in estuaries. The species of Lepisosteus are well known as large predatory fresh-water fishes. Several of these species frequent brackish-water salt marshes and may be found in the open Gulf of Mexico (Hoese and Moore, 1977:125-126).

The modern tarpon, Tarpon atlanticus, is primarily a coastal fish and is rarely seen more than a few kilometers from land. Although it generally lives in brackish and salt water, it also ascends fresh-water streams such as the San Juan River and is known to inhabit fresh-water lakes including Lake Nicaraugua and Gatun Lake, Canal Zone (Hildebrand, 1963:116). Hildebrand (1963:117) reported

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that small individuals are common in mangrove swamps and estuaries. The normal range of I. atlanticus in the western Atlantic Ocean reflects a sensitivity to cold waters and extends from North Carolina to Brazil, although rare records are known from as far north as Nova Scotia in warm months (Hildebrand, 1963:120). An eastern Atlantic Ocean population occurs along the coast of tropical West Africa. The other living member of the Megalopidae, Megalops cyprinoides, is a coastal Indo-Pacific Ocean fish which also enters fresh water. It inhabits waters between latitudes 40 North and 40 South, from the east coast of Africa to the Society Islands (Forey, 1973:64).

Today, Arius felis is commonly found in salt marsh channels, lagoons and shallow coastal waters. These catfish also enter fresh water in some areas (Migdalski and Fichter, 1976:163). Modern scianids occur in tropical and temperate waters. Nearly all are inshore species which are usually caught over sandy bottoms (Migdalski and Fichter, 1976:242). The black drum, Pogonias cromis, is a mollusc-eater with a preference for oysters (Migdalski and Fichter, 1976:243). The morphologic similarity between the jaws of Diaphyodus and P. cromis indicates they had similar diets.

Until the taxonomic assignment of the Casa Blanca anurans can be refined, little paleoecologic information can be determined by their presence, as modern anurans live in a wide spectrum of terrestrial habitats as well as fresh and salt water.

Modern members of the families of Casa Blanca turtles have a varied geographic distribution. The only living dermatemyid species,

Dermatemys mawei, is restricted to rivers in southern Mexico, Belize, Honduras and Guatemala (Moll,1986:88). Moll (1986:89) recently collected several individuals from the brackish water of Corozal Bay, northeastern Belize, and suggested that undiscovered coastal populations may exist. The distribution of the two living staurotypine genera, Staurotypus and Claudius, is limited to streams, lakes and lagoons of southern Mexico, Guatemala and Belize.

Modern emydids have a cosmopolitan distribution except for sub-Saharan Africa and Australia. Most emydids live in fresh water; a few are terrestrial; and three species, Malaclemmys terrapin, Pseudemys alabamensis, and Calagur borneoensis, are usually found in brackish water (Pritchard, 1979). Living testudinid tortoises are terrestrial and have a cosmopolitan tropical and subtropical distribution, except for Australia.

The sole extant species of the previously wide ranging carettochelyid family is Carettochelys insculpta, whose distribution is limited to southern New Guinea and northern Australia (Cann, 1978:67). This turtle is unique in being the only living freshwater species to possess limbs modified to flippers. C. insculpta inhabits coastal rivers and occasionally is found in their estuaries (Cann, 1978:69). It also inhabits fresh-water Lake Jamoer, New Guinea, in association with sharks and sawfish and may be capable of making open marine excursions (Pritchard, 1979:659).

Living species of Trionyx are primarily found in fresh-water lakes and streams. The Florida softshell (T. ferox) is also found in

brackish water, while the Nile softshell (T. triunguis) can be found in the nearshore and river mouth areas of the Mediterranean Sea (Pritchard, 1979:625). One Turkish coastal population of the latter species inhabits waters with depths of 11-27 m and a salinity of 38 $^{0}/_{00}$ (Pritchard, 1979:640).

Case (1925:97) has suggested that the morphology of the blunt teeth of Allognathosuchus is an adaptation for "a durophagous, probably conchifragous diet." If so, this specialized dentition would have been very useful in mollusc-rich estuaries. The modern American alligator (Alligator mississippiensis) inhabits fresh-water environments throughout most of its range, but is also prolific in coastal salt marshes and other estuarine habitats.

Glass lizards (Ophisaurus spp.) are the only modern anguid lizards currently inhabiting the North American Coastal Plain. These lizards live in a variety of terrestrial habitats (Behler and King, 1979:543-545).

The giant snake Pterosphenus schucherti has no close living relatives, but it has previously been found in estuarine or other hyposaline faunas in Georgia (Holman, 1977) and Arkansas (Westgate and Ward, 1981; Westgate, 1984). It is also known from deposits which appear to have been fully marine including sites in Florida (Hutchison, 1985), Alabama (Lucas, 1898) and Louisiana (McPherson and Manning, 1986). The presence of P. schucherti in the Casa Blanca fauna in addition to the Georgia and Arkansas faunas indicates that estuaries were probably an important habitat for these large snakes.

The occurrences of P. schucherti in offshore deposits indicate that the species probably spent considerable time there as well (Hutchison, 1985; McPherson and Manning, 1986).

PALEOHABITAT. Both the vertebrate and invertebrate faunal remains in the deposit at the Casa Blanca quarry show evidence of post-mortem transport and all must be considered allochthonous. Modern representatives of the lower vertebrates primarily display the following range of habitats (Table 9): chondrichthyans and most of the teleosts are nearshore to estuarine species; gars, some anurans, most of the turtles, and crocodilians are fresh water to estuarine inhabitants; while tortoises, lizards and some anurans are terrestrial or arboreal species.

Modern relatives of the Casa Blanca marine fishes are generally found in tropical to warm temperate waters. Modern crocodilians and testudinid turtles live in tropical or subtropical climates. The carrettochelyid, dermatemyid and staurotypine turtles are today restricted to the tropics. This implies that the Rio Grande Embayment climate during deposition of the Casa Blanca quarry horizon was no cooler than subtropical. Evidence from the chelonians indicates it was most likely tropical and may have been similar to the climate of coastal southern Mexico and northern Central America where modern dermatemyid and staurotypine species are found today.

The paleoclimatic evidence provided by land snails associated with the Serendipity and Candelaria local fauna mammals from the middle Eocene volcanic highlands of Trans-Pecos Texas agrees with

TABLE 9. Habitats of modern relatives of lower vertebrates in the Casa Blanca local fauna.

	Climate/ Water Temp.	Terrestrial	Freshwater	Estuarine	Nearshore	Infralittoral	Circalittoral	Oceanic
Odontaspidae	Tr-wTe	-	-	O	C	O	O	-
Carcharhinus spp.	Tr-wTe	-	C	C	C	O	O	O
Galeocerdo cuvieri	Tr-wTe	-	-	C	C	C	C	O
Pristis spp.	Tr-wTe	-	O	C	C	R	-	-
Rhinobatos spp.	Tr-wTe	-	O	C	C	R	-	-
Dasyatis spp.	Tr-wTe	-	O	C	C	O	O	O
Myliobatis spp.	Tr-wTe	-	-	C	C	O	R	-
Rhinoptera spp.	Tr-wTe	-	-	C	C	O	-	-
Lepisosteus spp.	Tr-Te	-	C	C	O	-	-	-
Megalopidae	Tr-wTe	-	O	C	C	R	-	-
Arius felis	Tr-wTe	-	R	C	C	C	-	-
Sclanidae	Tr-Te	-	C	C	C	O	-	-
Anura	Tr-Te	C	C	R	-	-	-	-
Dermatemyidae	Tr	-	C	O	-	-	-	-
Staurotypinae	Tr	-	C	-	-	-	-	-
Emydidae	Tr-Te	C	C	C	-	-	-	-
Testudinidae	Tr-Su	C	-	-	-	-	-	-
Carettochelyidae	Tr	-	C	C	-	-	-	-
Trionyx spp.	Tr-Te	-	C	O	O	-	-	-
Crocodylidae	Tr-Su	C	C	C	O	R	-	-
Anguidae	Tr-Te	C	-	-	-	-	-	-

C=common, O=occasional, R=rare, Su=subtropical,Te=temperate,Tr=tropical, wTe=warm temperate

the above interpretation of the Rio Grande Embayment paleoclimate. Roth (1984) described new species of Lysinoe and Polymita from the Uinta C correlates of Trans-Pecos Texas. Lysinoe ghiesbreghtii, the closest living species to the fossil Lysinoe species, inhabits forests of southern Mexico and Central America (Roth, 1984:213). The closest living relative of the fossil Polymita species inhabits seasonal tropical forests in Cuba (Roth, 1984:213).

The habitat accounts above indicate that remains of taxa from several local ecological communities are buried in the Casa Blanca quarry deposit. The large number of Crassostrea fragments implies deposition occurred in a hyposaline environment with Crassostrea bioherms nearby, probably in an estuarine setting. The marine species likely entered this environment during dry periods when salinities were relatively high, although most of these species are physiologically able to tolerate hyposaline conditions. Many of the fresh water species are also able to tolerate minimal hyposaline conditions and may have actively entered the area in life, especially during the wet seasons when salinities were lowest. The remains of the terrestrial species, including most of the mammals, and some fresh water species, were probably transported by coastal river currents to the sediment entrapping basin of the estuary. Arboreal species may have fallen into the hyposaline waters directly from hygrophilous trees such as mangroves. Nypa palm pollen was recovered from the drilled core near the quarry horizon and indicates the presence of a mangrove swamp community (Dr. Carol Gee, written

commun., 1988). Some vertebrate remains were undoubtedly transported inside predators and scavengers. The etched appearance of a tooth of Thisbemys sp. (Fig. 22A) may be the result of low pH conditions in the digestive tract of such an animal.

The precise salinity level at the depositional site cannot be directly ascertained. The living oyster, Crassostrea virginica, builds reefs in Texas bays which have salinities ranging from 10 to 30 $^{0}/_{00}$ and temperatures ranging from 10 to 25 C (Calnan, 1980:19). The late Eocene estuarine fauna collected from exposures on Crow Creek in St. Francis County, Arkansas (Westgate, 1982, 1984, 1985) shows evidence that estuarine salinities were higher at that site than those which occurred at the Casa Blanca site. Teeth of at least five species of sharks, as well as those from barracuda and cutlassfish are common in the Crassostrea biohermal facies at Crow Creek. Only one gar tooth and no gar scales were found associated with the bioherm. Only two land mammal specimens were recovered (Westgate and Emry, 1985).

In comparison, the Casa Blanca shark fauna is less diverse than that at Crow Creek with only three shark species. There is no evidence of barracuda or cutlassfish at the Casa Blanca site. Gar remains are the most common elements in the fauna with almost 400 identified specimens. Over 600 land mammal specimens have been recovered.

Approximately five tons of bulk sample from the Casa Blanca quarry was screen-washed, while only about one-half ton was

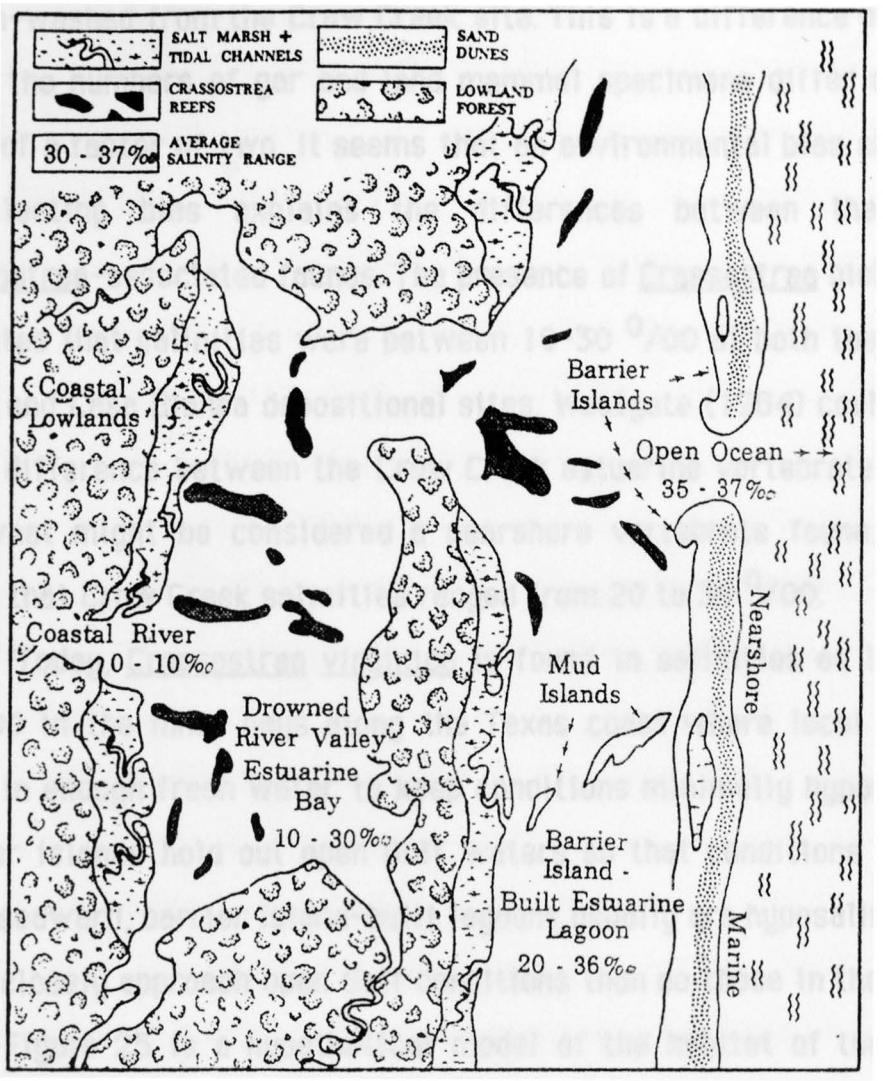

FIGURE 25. A hypothetical reconstruction of the coastline at Laredo during deposition of the Casa Blanca local fauna fossils. An alternative view would replace the salt marsh facies with a Nypa-mangrove swamp community in the intertidal zone.

screen-washed from the Crow Creek site. This is a difference of 10:1 while the numbers of gar and land mammal specimens differ on the order of a factor of two. It seems that an environmental bias and not a collecting bias explains the differences between the two Crassostrea-associated faunas. The presence of Crassostrea bioherms indicates that salinities were between 10-30 $^{0}/_{00}$ at both the Crow Creek and Casa Blanca depositional sites. Westgate (1984) could find little difference between the Crow Creek estuarine vertebrate fauna and what might be considered a nearshore vertebrate fauna. It is likely that Crow Creek salinities ranged from 20 to 30 $^{0}/_{00}$.

Today, Crassostrea virginica is found in salinities as low as $10^{0}/_{00}$ in the inner bays along the Texas coast where local rivers bring in enough fresh water to keep conditions minimally hyposaline. Barrier islands hold out open Gulf waters so that conditions in the more seaward, barrier island-built lagoons usually are hyposaline, but more closely approach open Gulf conditions than do those in the inner bays. Figure 25 is a hypothetical model of the habitat of the Casa Blanca fauna. Crassostrea bioherms were living on sandy bottoms in waters with salinities approaching 10 $^{0}/_{00}$ in an inner bay fed by coastal river drainage. Other Crassostrea bioherms and a vertebrate community similar to the Crow Creek fauna may have existed in nearby barrier island-built lagoons having higher salinities.

The composition of the local botanical community must await the completion of the palynological analysis being conducted by Dr. Carol Gee (Swiss Federal Institute of Technology, Zurich). If mangrove

swamps grew along the adjacent shoreline, the shell deposit may have formed as a wave-generated shell mound offshore of the swamp. The absence of abundant logs and root systems excludes deposition in an intertidal channel within a mangrove swamp. Resumption of mud deposition would bury the shell hash. If a marsh grass community locally grew in the shallows of the bay, then the vertebrate bearing deposit may have originated through storm overwash filling a saltmarsh tidal channel with shell debris and vertebrate remains. Absence of saltmarsh pollen would preclude this scenario. Both scenarios would produce a lenticular shelly deposit underlain and overlain by muddy substrates such as those exposed in the Casa Blanca quarry.

PALEOZOOGEOGRAPHY. Discovery of the Casa Blanca fauna has greatly expanded the paleozoogeographic ranges of nearly all of the taxa in the fauna. The small Guanojuato fauna of central Mexico contains four mammalian taxa (Ferruquia-Villafranca, 1984:189) and is the only more southerly North American mammal fauna of possible Eocene age, although it may be as young as early Oligocene (Black and Sutton, 1984:67; Ferrusquia-Villafranca, 1984:189). None of the Casa Blanca mammals are found at Guanojuato and the Laredo locality is the southernmost occurrence of its mammalian species (excepting the sirenian) in North America. Lillegraven (1979:336) noted that the Eocene deposits at San Diego have been shifted through fault slippage some 365 km (220 mi) to the northwest from an original location due west of the present Nogales, Arizona/Mexico area. This adjusted

position places the original Eocene San Diego depositional sites about 480 km (300 mi) north of the present latitude of Laredo and about 240 km (150 mi) north of the present latitude of the Trans-Pecos Eocene mammal-bearing deposits. A late Paleocene or early Eocene fauna is known from Punta Prieta in Baja California (Ferrusquia-Villafranca, 1984:187) at about the latitude of Big Bend National Park, Texas. This fauna may have originally lived at a more southerly latitude than the Casa Blanca fauna, as the former has undoubtedly been displaced by Cenozoic strike-slip faulting.

In composing the southernmost undoubtedly Eocene North American fauna, the Casa Blanca mammals provide the best known insight into the middle Eocene mammal faunas of eastern Mexico and Central America. Except for the small Guanojuato fauna, Eocene mammals are unknown from this region and there has been much speculation on the mammalian evolution which occurred there, especially regarding the ancestors of the South American primates and rodents (Wood, 1972, 1973, 1980; Lavocat, 1980; Black and Sutton, 1984). In addition, the Casa Blanca mammals compose the easternmost Uintan fauna in North America, although a few isolated specimens have been found in more easterly deposits of the coastal plain.

The lower vertebrates in the Casa Blanca fauna are also of paleozoogeographic interest. This is the westernmost Paleogene vertebrate fauna from the Gulf Coastal Plain. Three fishes and a turtle are reported from the Eocene of North America for the first

time. The tiger shark Galeocerdo eaglesomei has previously been reported only from middle Eocene deposits in Africa and the Persian Gulf area. The Casa Blanca megalopid is the first record of a tarpon in North American Eocene deposits. The same is true of Diaphyodus which previously was only known from the Paleogene of Europe. The Casa Blanca carrettochelyid more closely resembles Allaeochelys of Europe than it does previously described North American taxa. The sea snake Pterosphenus is reported from the North American middle Eocene for the first time.

The occurrence at Laredo of middle Eocene saltwater species which are conspecific with or related to African and European taxa is not surprising in view of the modern trans-Atlantic distribution of many of lower vertebrates. The presence of G. eaglesomei, Pterosphenus schucherti and the sirenian indicate that the marine aspect of the fauna was not only trans-Atlantic, but also trans-Tethyan, and that the middle Eocene Tethyan Province extended along the Gulf Coast at least as far west as the Rio Grande Embayment.

CONCLUSIONS

Exposures of the middle Eocene Laredo Formation, Claiborne Group, just east of Laredo in Webb County, Texas have yielded the first Eocene land mammal fauna from the coastal plain of North America. This fauna is here named the Casa Blanca local fauna and includes at least 30 mammalian taxa, a bird, 10 reptile, one anuran, six osteichthyan and eight chondrichthyan species.

Only nine land mammal specimens have previously been reported from Eocene deposits elsewhere on the North American Coastal Plain. The paucity of Eocene land mammal discoveries in the Eocene marine and marginal marine deposits of the coastal plain and their absence in interfingering continental deposits allowed only superficial correlations between Eocene deposits of the continental interior and the coastal plain. The prior existence of Eocene regional climatic, edaphic and floral effects on local mammalian communities limited the precision of these continent-wide correlations based on isolated and fragmentary mammalian remains.

The Casa Blanca local fauna vertebrate correlations within North America are based on over 600 mammal specimens representing at least 30 species. The Casa Blanca local fauna displays a stage of evolution similar to the Serendipity and Candelaria local faunas of Trans-Pecos Texas, the Uinta C local fauna and its correlates in the Rocky Mountain Region, the mammalian fauna from the Santiago

Formation of southern California, and the Swift Current Creek local fauna of Saskatchewan, Canada. Marine invertebrates in the Laredo Formation allow its correlation with the Cook Mountain Formation of central and east Texas, Louisiana, Arkansas and Mississippi; the upper Lisbon Formation of Alabama; the McBean Formation of Georgia; the Santee Limestone of South Carolina; the Castle Hayne Formation of North Carolina; and the Piney Point Formation of Virginia, Maryland, Delaware and New Jersey. This is a nearly continuous correlation along the coastal plain from northeastern Mexico to New Jersey, over a distance of about 3000 km (1850 mi). Nannoplankton fossils in these stratigraphic units are placed in the upper part of NP Zone 16 and are correlated to the upper Lutetian and lower Bartonian deposits of Europe. Therefore, deposits in North America bearing Uinta C mammalian faunas were deposited at approximately the same time as middle Eocene, upper Lutetian or lower Bartonian strata in Europe.

Bentonite deposits in the Hurricane Lentil, Landrum Member, of the Cook Mountain Formation of Houston County, Texas yielded K/Ar dates averaging 42.2 Ma. The Hurricane Lentil deposits have been correlated with the middle part of the Laredo Formation, including the Casa Blanca quarry horizon, using the gastropod Turritella cortezi. The middle portion of the Laredo Formation is independently correlated with the middle member of the Devil's Graveyard Formation of Trans-Pecos Texas which is the source of the Serendipity local fauna whose mammals closely resemble those of the Casa Blanca local fauna. A volcanic ash above the horizon bearing the

Serendipity fauna yielded a K/Ar date of 42.7 Ma, while a tuff below that horizon yielded a K/Ar date of 43.9 Ma. These K/Ar dates indicate that the Casa Blanca local fauna has a minimum age approaching 42.2 to 42.7 Ma, and a maximum age of 43.9 Ma. The two younger dates are probably closer to the actual age of the Casa Blanca horizon as the Casa Blanca vertebrate fauna appears to lie stratigraphically slightly above the Hurricane Lentil bentonites .

The lower vertebrate assemblage in the Casa Blanca fauna provides insight into the paleoclimatic conditions which existed in the Rio Grande Embayment region during deposition of the bone-bearing deposit. The continental vertebrates show that local climatic conditions were no warmer than subtropical and were likely similar to the tropical conditions which presently exist in the coastal areas of southern Mexico and northern Central America. The marine vertebrates indicate that water temperatures were tropical to warm temperate. Associated invertebrates indicate that the water was hyposaline with salinities in the range of 10-30 $^{0}/_{00}$. The species composition of the fish fauna gives evidence that salinities were in the lower end of this range and probably were close to 10 $^{0}/_{00}$. Deposition likely occurred in an inner estuarine bay directly influenced by fresh-water river effluent.

The Casa Blanca fauna provides new paleozoogeographic information in being the southernmost and easternmost definitely Eocene land mammal fauna in North America. This fauna provides the best direct evidence of the vertebrate community which existed in

eastern Mexico and Central America during the middle Eocene. The Casa Blanca fauna is also the westernmost Paleogene vertebrate fauna from the Gulf Coastal Plain. Three fishes and a turtle which were previously known only from deposits east of the Atlantic Ocean, are reported from North America for the first time. The giant sea snake Pterosphenus is reported from middle Eocene deposits of North America for the first time. This marine vertebrate fauna indicates that a Tethyan marine community existed at least as far west as the Rio Grande Embayment of North America during the middle Eocene.

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